2006
Louisiana Coastal Protection and Restoration

July 2006

Preliminary Technical Report to United States Congress

Executive Summary

By many measures the 2005 hurricane season was the worst in the Nation's history. Storms striking the Louisiana coast took over 1,800 lives, destroyed billions of dollars of residential, commercial, and public property, and changed the landscape of the Louisiana coast. Across America and around the world people were shocked by the images of destruction along the Gulf Coast in the most active Atlantic hurricane season in recorded history, witnessing the unprecedented formation of three powerful "Category 5" storms in the Gulf of Mexico. In response, the U.S. Congress has directed the Secretary of the Army, through the Chief of the U.S. Army Corps of Engineers to **"conduct a comprehensive hurricane protection analysis and design…to develop and present a full range of flood control, coastal restoration, and hurricane protection measures...[and] the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane...[and] the analysis shall be conducted in close coordination with the State of Louisiana."**

Flooded Homes in St. Bernard Parish, Louisiana

The Corps of Engineers and the State of Louisiana have assembled a team of expert scientists and engineers from more than 30 organizations including universities, private firms, environmental organizations, State and Federal governmental agencies, and international groups. This integrated team is working to forward the goals and objectives of the Louisiana Coastal Protection and Restoration (LACPR) reports by producing the design and analysis required to enhance hurricane risk reduction in coastal Louisiana. Close coordination has been established with the State of Louisiana's Coastal Protection and Restoration Authority (CPRA). This local authority was established to coordinate hurricane risk reduction and coastal restoration activities in Louisiana. In conducting analysis and developing designs, the LACPR team has made a concerted effort to use the best available scientific and engineering information and to work closely with its partners and the public.

Hurricane Risk Reduction Decision Framework

A decision framework is being developed to present a set of matrices necessary to communicate an array of information for policy makers. The framework will be designed to present information and data that will facilitate analysis and consideration of a range of scaled alternatives that will require further engineering analysis and design before projects can be recommended for authorization. Indeed, a decision framework that can be well understood by the public and decision-makers is the only means by which priorities for particular alternatives may be confirmed. The decision framework will be used by Congress and other laypersons as well as by engineers and trained analysts to consider a vast array of information necessary to make informed decisions.

The framework will present data in layers of matrices that organize the information in a logical sequence, as follows:

- Confirmation of geographic planning units for South Louisiana.
- Description of assets at risk in each of the planning units.
- Identification of screening storms and probability of annual recurrence as they affect planning units.
- Development and evaluation of structural, non-structural, and coastal restoration measures appropriate for each planning unit.
- Integration of component measures into alternative plans.
- Estimation of costs for each of the scaled alternatives identified for the planning units.
- Recommendations for further engineering and design investigations of the most promising specific measures to provide increased levels of risk reduction.

Because of the need to effectively integrate and display different kinds of data to decision-makers development of a decision framework is complicated. It is anticipated that a draft framework that has the utility to begin to inform decisions will be developed by October 2006; it may take longer to produce relevant information. The framework will develop and display data for a full range of scaled alternatives for measures for a variety of hydrologic areas and storm characteristics.

Decisions on whether to build particular projects, and which projects to build, are inherently policy decisions, and will be beneficially informed by the type of analytical information that the LACPR process will provide. Developing a decision-making framework that is more robust than the normal National Economic Development (NED) framework is a practical necessity that will facilitate more robust, comprehensive decision-making. Moving forward, this report will focus on supplementing the well-established and well-understood NED analysis with risk-based models of storm damage and risk to human life and property, so that decision-makers can more accurately assess the relative merits of potential protective and mitigating actions.

This Preliminary Technical Report provides an outline and schedule for developing a Final Technical Report. Interim Technical Reports are anticipated, and may include information on component parts of the system suitable to support authorization of detailed engineering studies or other construction decisions, consistent with the Administration's intention that any Federal funding for additional analysis or for construction would be subject to annual budget requests and necessary authorizations. Confirmation of any future authorization would be informed through the application of the decision framework. The Final Technical Report will fully respond to the direction provided by Congress to develop and present a full range of flood control, coastal restoration, and hurricane risk reduction measures in a comprehensive system approach. The intention is that any decision for Federal funding of further feasibility analysis or of construction of particular features will be informed and confirmed by the LACPR risk reduction decision framework and will be considered in annual budget requests and subject to necessary authorizations.

Coastal Features: Restoring the First Line of Defense

Protecting Louisiana's citizens, natural resources, and industries from hurricanes, nature's most powerful storms, is an enormous water resources challenge. Prior to the 2005 hurricane season, the Corps of Engineers and State of Louisiana were working together on plans to restore the State's eroding and deteriorating coastline. This joint effort was considered one of the most important ecosystem restoration efforts in the Nation. Hurricanes Katrina and Rita resulted in the destruction of more than 217 square miles of coastal wetlands during their landfalls. This 2-day loss exceeds the wetland losses that had been projected to occur in the State over the next 20 years. Viewed in relation to the New Orleans area, all of the wetlands that were expected to erode over 50 years were lost in a single day during the landfall of Hurricane Katrina.

Continuing losses of wetlands in Louisiana brings the Gulf of Mexico closer to coastal communities and increases the likelihood of damages from storms of all magnitudes. In addition to considering ongoing wetland loss, the LACPR team is faced with engineering a plan in an environment of poor soil foundation conditions, high subsidence rates, and the unknown scale of effects of sea level rise and future storms. Nothing less than the ultimate survival of one of America's great cities is at stake with vital international trade and national energy production hanging in the balance.

The LACPR team has recognized that the first line of defense against storms is Louisiana's coastal ecological features including barrier islands, marshes, ridges, and coastal forests. The people of coastal Louisiana are engaged in a battle against the encroaching Gulf of Mexico. A tenet of efforts to restore and sustain coastal ecosystems dictates that risk reduction measures not destroy these resources. As such, plans to restore coastal features as natural lines of defense are an integral part of an overall storm risk reduction and survival plan for Louisiana. These coastal lines of defense may be especially key during lower intensity but higher frequency storm events. Building a strong structural hurricane risk reduction system of levees and other barrier structures augmented with a restored and sustainable coastal ecosystem offers the best opportunity for success to save and protect coastal Louisiana's citizens and economy. Further, individuals and businesses have many opportunities to incorporate non-structural measures, such as elevating homes and improving evacuation plans, into their own recovery planning and rebuilding efforts.

Consideration of the costs for building an integrated hurricane risk reduction system should recognize the importance of coastal Louisiana to America's economy. Without risk reduction, important economic sectors including oil and gas, international shipping, shipbuilding, agriculture, seafood, tourism, and medical technology face uncertainties about storm risks. Construction of a stronger and integrated hurricane risk reduction system would provide more certainty to these critical industries fostering a more robust recovery for the economic engines of southern Louisiana.

Across South Louisiana 23 parishes are subject to various levels of inundation by hurricane storm surges. These coastal parishes contain 55% of the State's population or over 2.4 million people whose lives and property are at risk. Coastal Louisiana provides an integral national security function by supporting energy independence, balance of trade, and the efficient and effective transportation of commodities. Even if the populated areas located behind existing hurricane risk reduction systems can be made safer through increasing levels of risk reduction, the losses of coastal wetlands outside of the risk reduction system pose an increasing threat to the economic and environmental sustainability of the region.

Characterizing the Hurricane Threat to Greater New Orleans

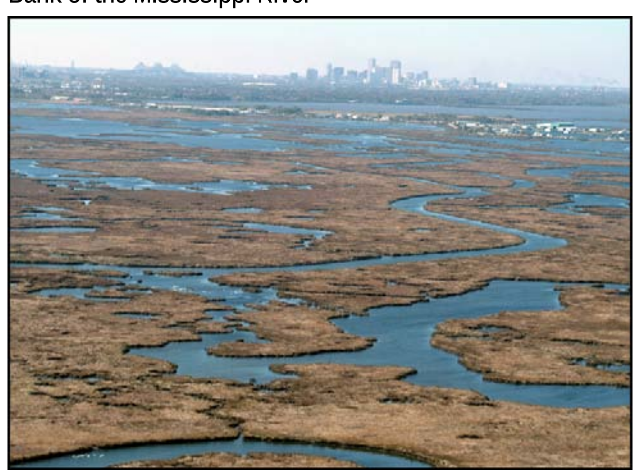
The greater New Orleans area flanks the east and west banks of the Mississippi River and is surrounded by a series of large estuarine bays and lakes. Although the city is about 100 river miles inland from the Gulf of Mexico, its location along the shores of these bays and lakes and the rapid loss of coastal wetlands now places the city very close to the open sea. Combined with low-lying topography, in some cases below sea level, the city and surrounding communities face significant flooding risks from rainfall, spring river runoff, and hurricane storm surges. A significant local and Federal investment in levee and drainage systems helps to support and protect residents that work in the area's vital port, energy production, seafood, medical and military manufacturing economic sectors. Each of these business areas produces important goods and services for the region and Nation in turn helping support the unique cultural heritage of the city known for the birth of jazz, vibrant arts, and famous cuisines.

As hurricanes approach the New Orleans area, storms push and carry ocean surges and waves across the surrounding wetlands and into the bays and lakes. In some cases, powerful coastal storms also push surges up the Mississippi River many miles above New Orleans. This scenario leaves greater New Orleans an island surrounded by storm surge and dependent upon levee systems to prevent inundation. Many years of coastal erosion coupled with Hurricane Katrina's damages to the estuaries surrounding New Orleans have reduced the natural storm defenses around the city by more than 500 square miles. The direct physical losses from Hurricane Katrina have been estimated to exceed $90 billion and reverberations have been felt in the energy, agriculture, trade, transportation, seafood, and insurance sectors nationwide.

The Corps of Engineers has completed emergency repairs to 169 miles of levees and floodwalls damaged or destroyed during Hurricane Katrina. This work, carried out by Task Force Guardian, restored the hurricane risk reduction system to pre-storm authorized levels. Additional work approved by Congress and the Administration is being implemented to advance other projects to completion. Other hurricane risk reduction work in Louisiana was recently authorized by Congress in emergency authorization bills for storm recovery. The LACPR team is including all of these emergency repairs as part of the existing conditions to be considered in evaluating needs for upgrading the risk reduction to "Category 5" levels.

The current levee system protecting the New Orleans area is a result of a complex series of decisions regarding locations, designs, environmental impacts, and levels of risk reduction governed by local agreements, court cases, and Congressional authorizations and appropriations. The levee systems in place to protect this population are known to be inadequate because they were not designed to defend against nature's strongest hurricanes. A primary conclusion of the Interagency Performance Task Force (IPET) team and other post-Katrina evaluations has revealed that the area's hurricane risk reduction structures do not function as an integrated system as intended or needed. As a result, the greater New Orleans area continues to face significant risks from powerful Gulf hurricanes.

New Orleans Skyline Fronted by Wetlands on the West Bank of the Mississippi River



Risk Reduction Approach

The widespread use of the Saffir-Simpson Scale, a scale for categorizing hurricane wind damages, for weather forecast warnings and media reporting has established public demand for levels of risk reduction in South Louisiana tied to "Category 5" events. However, Corps of Engineers designs and Congressional project authorizations have historically been centered on composite storms, or Standard Project Hurricanes, that have characteristics that do not fit into a single Saffir-Simpson category but rather have winds, barometric pressures and storm surges falling within several classification categories. The team has been challenged to meet a "Category 5" project standard due to factors including strike probabilities and lack of historical data on storm strengths. The LACPR effort provides an important opportunity to better inform the public of the actions involved in designing, building and maintaining a system capable of protecting South Louisiana from storms with sustained winds greater than 155 miles per hour and storm surge heights exceeding 18 feet.

Analyzing the efficiency of hurricane risk reduction by using the probability of storms and risk reduction instead of Saffir-Simpson damage prediction categories offers a more realistic and understandable approach for engineers, government leaders, and the public. The Corps of Engineers IPET and LACPR teams have identified a new risk-based assessment methodology for developing hurricane risk reduction plans that would include valuation of consequences to populations and assets at risk. This new methodology is emerging from post-Katrina forensic efforts and is being proposed as an improved approach for future engineering work and policy direction.

Development of this risk-based approach is underway and will include expert workshops, test applications, and independent technical review for verification. In short, the methodology seeks to transform development of what has been commonly called hurricane "protection" concepts and plans away from a single event-driven planning approach based upon cost benefit analysis to a more reasoned risk-based assessment. The LACPR final report will support the development of the methodology and incorporate it into a range of information to be presented to decision-makers.

A Vision for Success

A series of expert workshops and public meetings have been hosted by the LACPR team. A vision for success has emerged from the LACPR preliminary efforts. A "Category 5" storm striking Louisiana presents extreme weather conditions requiring planners and designers to develop multiple lines of defense using an integrated system of restored coastal features, strong structural barriers and levees, and non-structural features to protect lives and property.

Coastal ecological features form the outer line of defense against storm waves. Barrier island systems absorb waves from approaching storms and help limit the amount of water that enters estuaries in advance of tropical systems. Back-barrier marshes and coastal fringe wetlands act as tidal and wave buffers protecting inland features. Upper estuary forested systems provide further risk reduction through wind and surge reduction. Forested ridges formed on old river and bayou banks also provide wave and wind reduction during storm events.

The lessons of Hurricane Katrina show the dangers of depending upon a single line of levee defenses located adjacent to densely populated areas. In this case a single overtopping or failure can lead to catastrophic results. A better system approach would involve fighting storm surges on the outer fringe of populated areas with large surge barriers and armored levees fronted by natural coastal features. Also, coastal populations should recognize the extreme storm dangers and plan accordingly by using better construction techniques to withstand storms and efficient evacuation plans to move out of the paths of harmful hurricanes.

Steps to the Final Technical Report

Along with the development of the decision framework and the information within it, the LACPR team will focus on continuing the design and analysis for each plan alternative identified. Work to analyze the alternatives will include more refined hydrodynamic modeling, additional plan formulation, full ecosystem restoration planning and integration, risk and consequences analysis, initial engineering and design, environmental impact analyses, cost estimating, as well as more independent technical reviews and external peer reviews. A full-scale public involvement plan has been outlined to include continued interactive public meetings and events associated with the public comment periods to allow for review of the draft and final versions of the Final Technical Report and the PEIS. Efforts will continue to fully coordinate completion of this effort with other ongoing recovery planning efforts being conducted in Louisiana. Most importantly the LACPR team will continue to work closely with the State of Louisiana in its development of a Master Plan for hurricane risk reduction and coastal ecosystem restoration and the Final Technical Report.

The work remaining for developing the Final Technical Report is substantial and may result in some modifications and changes to the information presented, as well as substantial new results and findings. The LACPR team is aware of the complexity of the tasks at hand and the difficulties facing communities struggling to recover from the damages experienced in the 2005 hurricane season. Working closely with the assembled expert members, local residents and governments, and independent review panels offers the most effective and comprehensive means of addressing Louisiana's hurricane risk reduction and coastal restoration challenges.

We are seeking innovative concepts for addressing the comprehensive range of risk reduction measures that are the subject of the LACPR reports. This will include a request for interested parties to submit innovative designs and concepts for hurricane risk reduction measures. The public is invited now to propose innovative conceptual approaches so that they may be considered in interim reports or in the Final Technical Report, as appropriate. Once the new decision framework is available, the USACE-Louisiana CPRA team will solicit recommendations from interested parties as how to best consider innovative approaches for hurricane risk reduction strategies for South Louisiana.

Enclosures

This Preliminary Technical Report is informed by a number of documents that have been developed by the LACPR team. While these documents are not incorporated into the findings of this report they are useful for the insight they provide into traditional and alternative planning methodologies. Many of these documents are provided as enclosures to this report. Any findings or recommendations from the Enclosures are intended to provide information about the ongoing process, and should not be construed as recommendations to pursue a particular course of action.

17th Street Canal Breach at Hammond Highway Bridge

House in Road After Flooding in Chalmette, Louisiana (East of New Orleans)

Boats in Road Near Empire Bridge in Plaquemines Parish

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Introduction

In response to the devastating destruction caused by Hurricanes Katrina and Rita, both the Louisiana legislature and the United States Congress provided legislative directives to investigate and integrate hurricane risk reduction and coastal restoration for South Louisiana. Development of plans to meet these directives is being undertaken as a joint effort of the Federal government and the State of Louisiana. Although the State and Federal legislative directives are not identical, they do share the common fundamental objectives of considering the complete spectrum of landscape level uses and needs, and of incorporating a full range of potential risk reduction measures into an integrated plan. This plan must be evaluated based on its benefits in reducing storm damage to coastal communities and infrastructure, as well as for its ecosystem impacts and benefits.

The **purpose** of the project is to identify risk reduction measures that can be integrated to form a system that will provide enhanced protection of coastal communities and infrastructure, as well as for restoration of coastal ecosystems.

The **scope** of the project is to address the full range of flood control, coastal restoration, and hurricane protection measures available, including those needed to provide comprehensive "Category 5" protection.

Federal Authority

Authorization and direction for the Louisiana Coastal Protection and Restoration (LACPR) project is granted under the Energy and Water Development Appropriations Act of 2006 passed in November 2005 and the Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 passed on December 30, 2005, as part of the Defense Appropriations Act. Under these acts, Congress and the President directed the U.S. Army Corps of Engineers to:

- Conduct a comprehensive hurricane protection (risk reduction) analysis and design at full Federal expense to develop and present a full range of flood control, coastal restoration, and hurricane (risk reduction) measures exclusive of normal policy considerations for South Louisiana.
- Submit a preliminary technical report for comprehensive "Category 5" protection (risk reduction) within 6 months of enactment of the Act.
- Submit a final technical report for "Category 5" protection (risk reduction) within 24 months.
- Consider providing protection (risk reduction) for a storm surge equivalent to a "Category 5" hurricane within the project area.
- Submit reports on component areas of the larger protection (risk reduction) program for authorization as soon as practicable.

Category 5 Hurricane

A storm on the Saffir-Simpson Hurricane Scale having winds greater than 155 mph (135 knots or 249 km/hr). Storm surges are generally greater than 18 feet above normal. Only three "Category 5" Hurricanes have made landfall in the United States since records began: The Labor Day Hurricane of 1935, Hurricane Camille (1969), and Hurricane Andrew in August 1992.

State Authority

The Louisiana Legislature established the Coastal Protection and Restoration Authority (CPRA) through Acts 2005 First Extraordinary Session, No. 8. The Governor approved and signed Act No. 8 on November 28, 2005, calling for:

- A long-term comprehensive coastal protection plan combining hurricane protection and the protection, conservation, restoration, and enhancement of coastal wetlands and barrier shorelines or reefs.
- A plan that addresses hurricane protection and coastal restoration efforts from both short-term and long-range perspectives and incorporates structural, management, and institutional components of both efforts.

The coastal protection and restoration initiative directed by the language of Act 8 involves a master planning effort to support the full range of public and private interests in the coastal landscape. This planning effort entails providing both protection from hurricane surges and coastal ecosystem sustainability immediately and over the long term. In addition, the State planning effort is intended to support and guide the social and economic recovery efforts being administered through the Louisiana Recovery Authority. The Louisiana Comprehensive Coastal

Protection Plan Formulation Report is contained in Enclosure A.

Project Area

The LACPR project area stretches across Louisiana's coast from the Pearl River on the Mississippi border to the Sabine River on the Texas border. The project area is comprised of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the closely linked Chenier Plain, both of which are influenced by the Mississippi River.

The Deltaic Plain contains ecologically important estuaries fronted by numerous barrier islands and headlands, including the Chandeleur Islands, Barataria Basin Barrier Islands, and Terrebonne Basin Barrier Islands.

The Chenier Plain contains important diverse wildlife and fisheries habitat that extends from the Teche/Vermilion Bays to Louisiana's western border with Texas, and is characterized by several large lakes, marshes, cheniers (oak ridges), and coastal beaches.

LACPR General Project Area

Exceptions to Normal Policy Considerations

The LACPR effort is a technical analysis and design effort for one of the most complex water resource management missions ever conceived. It is neither a formal reconnaissance study nor a feasibility study, and it is not being developed according to normal policy guidelines that apply to the formulation of plans and the selection of alternatives. These exceptions enable the team to operate with more flexibility than formal reconnaissance and feasibility civil works planning because of the urgent need for the information that will allow policy-makers and legislators to chart the way forward for the Louisiana Gulf Coast. The robust decision framework developed by the LACPR study can inform these decision-makers of means by which the risk and consequences of major storm events can be reduced. Nonetheless, the approach followed will be consistent with the established planning principles found in the Corps Planning Guidance Notebook and the sequential decision framework. This work will lead to a comprehensive plan, with an array of scaled alternatives for which additional authorizations for studies, design, analysis or construction may be required.

As in the companion Mississippi Coastal study (discussed below) this Louisiana Coastal study's recommendations will not be guided solely by the traditional National Economic Development analysis. The LACPR team will make recommendations using an assessment of economic and non-economic assets at risk and consequence analyses.

The **National Environmental Policy Act (NEPA)** of 1969 requires federal agencies to include environmental values in their decision-making processes by considering the environmental impacts of proposed actions and reasonable alternatives to those actions. Public involvement is required and included throughout the process. For the LACPR project a Draft Programmatic Environmental Impact Statement is scheduled for public release in early Spring 2007.

Similarly, this study will not be limited by the minimum 800-cfs drainage capacity requirement that is specified in Engineering Regulation 1165-2-21 (Flood Damage Reduction Measures in Urban Areas).

The LACPR team will conduct an economic assessment of assets at risk and consequences analysis. This study will comply with all environmental laws. The LACPR reports will include preparation of a Programmatic Environmental Impact Statement (PEIS). The PEIS will describe and evaluate proposed actions and alternatives, including a no-action alternative. The PEIS will detail the potential direct, indirect, and cumulative impacts of implementing flood control, coastal restoration, and hurricane risk reduction measures for South Louisiana. Through a series of public meetings, a PEIS was initiated at the beginning of the preliminary report development and is being advanced as a separate, but integrated, effort intended for completion at the same time as the Final Technical Report.

Preliminary, Interim, and Final Technical Reports

This Preliminary Technical Report is the first required deliverable of the project. Prepared subsequent to the first six months of effort since the project was authorized, it describes the initial findings of technical analysis for increased comprehensive hurricane risk reduction across South Louisiana through the integrated water resources planning objectives of flood control, coastal restoration, and hurricane risk reduction. It also presents a decision-making framework that can be used by policy makers and legislators to evaluate different risk-reduction alternatives in the post-Katrina situation where normal policy considerations cannot be reasonably applied.

Interim Technical Reports are anticipated, and may include information on component parts of the system suitable to support authorization of detailed engineering studies or other construction decisions, consistent with the Administration's intention that any Federal funding for additional analysis or for construction would be subject to annual budget requests and necessary authorizations. Confirmation of any future authorization would be informed through the application of the decision framework. The final report will fully respond to the direction provided by Congress to develop and present a full range of flood control, coastal restoration, and hurricane measures in a comprehensive system approach.

The Final Technical Report is the second required deliverable of the study. Due December 30, 2007, twenty four months after the study was authorized, it will contain fully populated matrices of information and present other engineering and technical information sufficient to enable policy makers to make informed decisions as to whether or not subsequent formal feasibility, engineering and design studies or construction are warranted. The intention is that any decision for Federal funding of further feasibility analysis or of construction of particular features will be informed and confirmed by the LACPR risk reduction decision framework and will be considered in annual budget requests and subject to necessary authorizations.

Emergency Response at the 17th Street Canal Floodwall in New Orleans

Project Delivery Team

The LACPR Project Delivery Team includes national and international science and engineering experts from inside and outside of government. Team members represent over 30 organizations including government agencies, academic institutions, environmental organizations, land owners, and private engineering firms. Neighboring Army Engineer districts along the Gulf Coast and other parts of the country and Planning Centers of Expertise are serving as technical peer reviewers. External peer review has also been solicited from national science and engineering organizations, regarding the planning, engineering, and science approaches. Both the internal and external peer reviews will be conducted periodically throughout the effort to verify the work of the LACPR team.

Coordination with Other Planning Efforts

The people of South Louisiana cannot create a vision of a sustainable coastal future without having information about levels of hurricane risk reduction. To address the challenges facing South Louisiana, the LACPR plan is being coordinated with other planning efforts through a continuous exchange of ideas and information. In addition, the Corps of Engineers is working to consider and coordinate other water resources plans and projects including navigation, flood control, and ecosystem restoration. These other planning efforts and programs are discussed below.

Louisiana Recovery Authority

The Louisiana Recovery Authority (LRA) guides the State's recovery and rebuilding efforts in the aftermath of Hurricanes Katrina and Rita. The LRA works across jurisdictions, in collaboration with local, State, and Federal agencies, to address short-term recovery needs and guide the long-term planning process. "Louisiana Speaks" is the LRA's long-term community recovery planning initiative. The LACPR team will share information on levee alignments, coastal restoration plans, and public feedback with the LRA Regional Visioning Team. In return, the Regional Visioning Team will share ideas about redevelopment scenarios and information on public preferences with the LACPR team.

Continuous feedback between the groups will occur at all levels, including the scientists, engineers, and planners working within the two planning efforts. Timing of the outputs is an important consideration. The LRA's Regional Vision Scenarios will be finalized in April 2007 and the LACPR report will be completed in December 2007. This schedule means that stakeholder preferences, along with the land use and transportation scenarios collected by the LRA, will be available for the LACPR effort.

Coastal Protection and Restoration Authority (CPRA) Master Plan

The State of Louisiana established the CPRA as the single State entity that will interface with the Corps of Engineers on LACPR project coordination, and will identify and integrate State, parish, and local interests, as well as that of non-governmental organizations. The CPRA will develop, coordinate, make reports on, and provide oversight for a comprehensive hurricane risk reduction master plan and annual risk reduction plans. It will work in conjunction with State agencies, political subdivisions, including levee districts, and Federal agencies. The Plan will clearly portray the State's desires and needs relative to hurricane risk reduction and coastal restoration. The Master Plan will include a comprehensive strategy addressing the risk reduction, conservation, and restoration of the coastal area through the construction and management of hurricane risk reduction and coastal restoration projects. The CPRA has been directed to develop the Master Plan on an expedited schedule in order to coordinate the efforts of other ongoing risk reduction efforts, particularly those of the Corps of Engineers. A common process is being applied for plan formulation for the LACPR and CPRA efforts to facilitate the development of seamless, if not identical, hurricane risk reduction plans.

Mississippi Coastal Improvements Program (MsCIP)

A technical evaluation will be conducted in close coordination and consultation with the State of Mississippi, Federal agencies, and stakeholders to determine the level of hurricane risk reduction and environmental restoration for coastal Mississippi. The water resources mission areas of hurricane risk reduction, flood control, interior drainage, navigation, and ecosystem restoration, must be integrated during plan formulation and evaluation to identify preliminary plans and designs that would provide increased hurricane risk reduction, as well as avoid or minimize unintended consequences from these actions. The LACPR team regularly communicates with the MsCIP team including face-to-face coordination meetings. The teams are using some common technical members to further coordinate development of both plans.

Coastal Ecosystem Restoration Plans and Programs

Long before the storm events of 2005, the Louisiana public and national policy makers recognized the need to restore and recover the valuable functions of the coastal wetland environment. This recognition led to the enactment of the Coastal Wetlands Planning, Protection and Restoration Act of 1990 (CWPPRA), and the completion and approval of plans such as Coast 2050 and the Louisiana Coastal Area (LCA)

Ecosystem Restoration Plan. The LACPR team is examining those plans and others to develop a set of ecosystem restoration components for integration into the LACPR plan. Coastal restoration features contribute to the overall hurricane risk reduction system by providing storm surge reduction, levee protection buffers, wind shields, and long-term operations and maintenance cost reductions.

Davis Pond Freshwater Diversion

Coastal Wetlands Planning, Protection and Restoration Act

The CWPPRA program provides for targeted funds to be used for planning and implementing small scale, short-term projects that create, protect, restore and enhance wetlands in coastal Louisiana. By 2006, 138 CWPPRA projects had been approved and 67 had been constructed, preserving or enhancing over 52,000 acres of marsh. Project size ranges from nine acres to 36,121 acres, illustrating the diverse objectives and methods being employed by program initiatives. The types of projects include freshwater and sediment diversion, outfall management, dredged material/marsh creation, shoreline protection, sediment and nutrient trapping, hydrologic restoration, marsh management, barrier island restoration, and vegetation planting.

Coast 2050: Toward a Sustainable Coastal Louisiana

In 1998, the State of Louisiana and its Federal partners approved a coastal restoration plan entitled Coast 2050: Toward a Sustainable Coastal Louisiana. That document presented strategies jointly developed by Federal, State, and local interests to address Louisiana's massive coastal land loss problem. Principles and strategies from the Coast 2050 plan are used in developing new projects in the CWPPRA program. A larger effort to advance the Coast 2050 plan to implementation was initiated in a series of feasibility studies under the LCA authority.

Louisiana Coastal Area Ecosystem Restoration Plan

The Louisiana Coastal Area (LCA) Ecosystem Restoration Study was initiated in 2001 by the Corps of Engineers and the State of Louisiana to address Louisiana's severe coastal land loss problem. The goal is to achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus, contribute to the economy and well-being of the Nation.

The LCA Plan includes programmatic authorization of five near-term critical restoration projects including the Mississippi River Gulf Outlet(MRGO) environmental restoration, a small river diversion at Hope Canal, Barataria Barrier shoreline restoration, a small Bayou Lafourche river reintroduction, and a medium river diversion at Myrtle Grove with dedicated dredging. Programmatic authorization is also requested for a Science and Technology Program and associated demonstration projects, beneficial use of dredged material, and studies to modify existing water control structures. Standard authorization is requested for 10 other near-term critical restoration projects and large scale and long-term concepts such as Mississippi River Delta Management. This Plan will restore critical deltaic processes and geomorphic structures and sustain diverse habitats.

The LCA Plan has been approved by the Chief of Engineers and the Assistant Secretary of the Army for Civil Works and transmitted to the Administration and Congress. The plan is awaiting action on a Water Resources Development Act bill for authorization.

Coastal Impact Assistance Program

The Coastal Impact Assistance Program (CIAP) was authorized by Section 384 of the Energy Policy Act of 2005. This federally funded program assists oil and gas producing coastal states and their political subdivisions in mitigating the impacts from Outer Continental Shelf (OCS) oil and gas production. CIAP funds can only be used for: 1) conservation, protection and restoration of coastal areas; 2) mitigation of damage to fish, wildlife and other natural resources; 3) planning assistance and administrative costs of CIAP compliance; 4) implementation of a federally approved marine, coastal or comprehensive conservation management plan; and 5) mitigation of the impacts of OCS activities via funding of onshore infrastructure projects and public service needs.

Preliminary estimates are that the CIAP will provide about $540 million to coastal Louisiana during Federal fiscal years 2007 through 2010; 65% of that funding will be allocated to the State of Louisiana, and the remainder will go to the 19 coastal parishes. The U.S. Minerals Management Service (MMS) must approve the State's Coastal Impact Assistance Plan and specific project grant applications before allocating funding to the State and parishes. The State intends to submit its CIAP Plan to MMS in October 2006.

Comprehensive Habitat Management Plan for Lake Pontchartrain Basin

The Comprehensive Habitat Management Plan for Lake Pontchartrain Basin was developed by a science and engineering committee and reviewed by a second panel of coastal experts. Proposed restoration projects that would also contribute to hurricane protection include:

- Restoration and protection of north shore riverine habitats (Upland Sub-basin).
- River reintroductions to sustain and re-build cypress swamps around Lake Maurepas (Upper Sub-basin).
- Restoration of the fringing marsh along the south shore of Lake Pontchartrain (Middle Sub-basin).
- Hydrologic restoration of St. Bernard and Plaquemines Parish's estuaries through constriction of the MRGO channel and river reintroductions (Lower Sub-basin).
- Restoration of wetlands on critical landbridges, including MRGO-Lake Borgne and East Orleans land bridges.
- Restoration of Chandeleur barrier islands.

Barataria-Terrebonne National Estuary Program

Louisiana's Barataria and Terrebonne basins were nominated for participation in the EPA administered National Estuary Program on October 16, 1989. In his nomination letter for the Barataria-Terrebonne National Estuary Program (BTNEP), the Governor of Louisiana stated, "Louisiana faces a pivotal battle in the Barataria-Terrebonne Estuarine Complex if we are to do our part in winning the national war to stem the net loss of wetlands..."

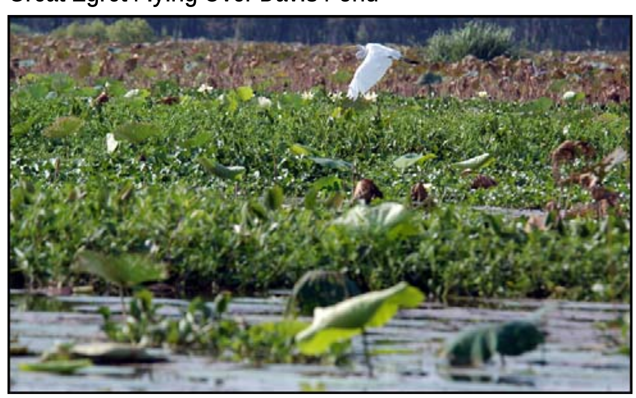
A coalition of government, private, commercial, conservation, and civic interests developed a Comprehensive Coastal Management Plan for the Barataria-Terrebonne Basin. It includes several engineered coastal restoration features including restoration of the Barataria-Terrebonne barrier islands, long distance pumping of sediment to quickly create marsh, small freshwater diversions, some to nourish created marshes, and shoreline stabilization. The BTNEP Management Conference is working with Federal, State, and local agencies to implement the Comprehensive Coastal Management Plan. Teams composed of experts and citizens are helping to implement action goals, furthering the ideal of stakeholder involvement and consensus.

Coastal Ecosystem Restoration Websites	
CWPPRA	www.lacoast.gov/cwppra
Coast 2050	www.coast2050.gov
Louisiana Coastal Area	www.lca.gov
Coastal Impact Assistance Program	www.mms.gov/offshore/ciapmain.htm
Lake Pontchartrain Basin Foundation	www.saveourlake.org
Barataria-Terrebonne National Estuary Program	www.btnep.org

Other Programs and Independent Groups

Many independent groups have produced information, letters, reports, and articles related to the recovery, restoration, and protection of coastal Louisiana after the 2005 hurricanes. The team has been provided materials and in some cases worked closely with the Bring New Orleans Back Committee, American Society of Civil Engineers, and independent scientists and engineers from around the country. These interactions are critical to planning and the team will continue to pursue these information exchange opportunities.

Great Egret Flying Over Davis Pond



Hurricane Risk Reduction Decision-Making Framework

The widespread use of the Saffir-Simpson Scale for weather forecast warnings and media reporting has established public demand for levels of risk reduction tied to "Category 5" events. However, Corps of Engineers designs and Congressional authorizations have historically been centered on composite storms, or Standard Project Hurricanes, that have characteristics that do not fit into a single Saffir-Simpson category but rather have winds, barometric pressures and storm surges falling within several classification categories. The team has been challenged to meet a "Category 5" standard due to a number of factors including strike probabilities, lack of historical data on upper limits of storm strengths, and the generally poor coastal conditions and soil characteristics found in South Louisiana. The LACPR effort provides an important opportunity to educate the public and reframe an understanding of the actions involved in designing, building and maintaining a system capable of protecting the area from storms with sustained winds greater than 155 miles per hour and storm surge heights exceeding 18 feet.

Methods used to estimate hurricane-related risks:

- Design storm method (examining Standard Project Hurricane, Probable Maximum Hurricane, and other scenarios)
- Joint Probability Method
- Modified Empirical Simulation Technique
- Synthetic Storm Method

A team of experts from government, academia, and private companies has been assembled to address the problem of evaluating hurricane exposure risks. The object of this effort is to provide probabilities of hurricane characteristics appropriate for modeling winds, waves, and surges for the entire Louisiana coast and to assess the exposure risks to wave and surges in this area. The evaluation will allow all selected design storms to be interpreted probabilistically in terms of expected return periods for scalar variables (such as total surge level) and multivariate behavior (such as surge level plus wave runup, plus rainfall). It should also provide objective information for selecting appropriate design storms in this region (i.e., what is the difference in level of risk reduction between a 100-year and a Category 5 storm?). With sufficient information, a more meaningful categorization of hurricanes in terms of potential surge levels will be developed rather than the present characterization embodied by the Saffir-Simpson Scale, which is suitable primarily for estimates of on-land wind damage to structures. Analyzing the efficiency of hurricane risk reduction by using the probability of storms and risk reduction instead of Saffir-Simpson damage classification categories offers a more understandable approach.

Primary parameters used to estimate realistic wind fields in hurricanes:

- Surface-level wind speed
- Radius to maximum wind speed
- Forward storm velocity
- Direction of storm heading
- Location of storm landfall

The treatment of additional parameters and the rate of change of storm intensity, will be examined to determine how these factors may affect the statistics of coastal waves and surges. This suite of methods will be distilled into a single "optimal" method for subsequent hurricane risk assessment.

Historical storms will be analyzed for:

- Limiting factors imbedded within the joint probabilities of hurricane parameters (i.e. factors that relate limits in storm size to intensity).
- Estimating storm decay approaching the coast.
- Analysis of wind fields within historical storms of the last century or so.
- Uncertainty in risk estimates due to decadal-scale variations in storm frequency and intensity.

This effort will investigate innovative means to reduce the number of storms simulations required while maintaining high fidelity in the computer simulations. The Interagency Performance Task Force (IPET) study simulated approximately 1800 storms to characterize surges in the New Orleans area. The LACPR team will attempt to reduce the number of storms modeled for the New Orleans area to between 200 and 300 computer simulations. However, a large number of storm simulations are required to populate the probability matrices across the Louisiana coast. The number of surge/wave model runs required increases approximately linearly as the length of study coastline increases.

Traditional Planning Background

The 1983 Principles and Guidelines (P&G) expresses Federal water resources project development policy. It is structured to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water and related land resources implementation studies. A plan recommended for Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (the NED plan), unless the Secretary of a department or head of an independent agency grants an exception to this rule. Exceptions may be made when there are overriding reasons for recommending another plan, based on other Federal, State, local and international concerns.

The P&G does, however, support using supplemental information on performance and economic risks to improve decisions. According to the P&G, planners must identify and describe areas of risk and uncertainty in their analysis so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. Other than this general guidance, P&G is silent on what risk analysis to conduct or how to make decisions when risk or uncertainty is influential on project performance. The Corps recommended plan has generally been the one that maximized expected net value in the limited guidance requiring quantitative risk assessment (EP 1130-2-500, Major Rehabilitation, and ER 1105-2-101, Flood Damage Reduction). That is, the NED plan is the alternative that maximizes expected net NED benefits. Because P&G provides little detail but a general philosophy of risk-informed decision-making, the LACPR project will develop and implement a decision approach following the P&G conceptual guidance.

Post-Katrina Planning Framework

Congress and the President have authorized the LACPR team to make recommendations “exclusive of normal policy considerations.” The State of Louisiana also agrees that the development of a policy decision framework is required to identify, analyze and select options for enhanced hurricane risk reduction for coastal Louisiana. This framework is necessary to assist policy makers in identifying scaled alternatives for projects so as to inform priorities for the potential investment of Federal and State dollars.

A decision framework should present data in ways that have utility for policy makers who will be expected to make decisions as to the most appropriate allocation of limited resources. In addition to standard identification of the costs and benefits of a particular storm risk reduction measure, a decision framework should enable decision-makers to assess a comprehensive range of assets and factors that warrant the greatest priorities for risk reduction measures.

Development of this kind of decision-making framework is a high priority for the LACPR team. The Final Technical Report will present the relative priorities for the scaled alternatives of hurricane risk reduction. Additional engineering analysis and design will be needed before projects can be authorized or constructed. An informed decision-making framework is the best means by which priorities for particular alternatives may be confirmed. Traditional NED calculations do not attempt to value such non-economic assets as human life. This means that alternatives are to be designed and recommended within the framework of policy, but that policy will not limit the decision framework. Therefore the development of a decision-making framework that is more robust than the normal NED framework is necessary. As a consequence, this Preliminary Technical Report describes the nature of the decision-making framework in development for application in coastal Louisiana. Also, this report provides an outline of and a schedule for the development of the Final Technical Report, which may include interim reports as relevant information is developed and analyzed.

This Preliminary Technical Report provides information that will guide the work necessary to complete the final report. The information herein does not provide the kinds of technical information necessary to authorize construction programs. Interim reports may be produced on component areas of more extensive risk reduction features that may prove suitable for authorization for feasibility level engineering studies or construction decisions. These reports would be consistent with the standard policy that any Federal funding for further analysis or for construction of hurricane risk reduction features be subject to annual budget requests and necessary authorizations. While a framework is being developed there is a concurrent opportunity and need to develop engineering and design analysis relevant to alternatives for increased levels of risk reduction in South Louisiana These alternatives may include coastal ecosystem restoration and non-structural measures. Such work is expected to be included in the Final Technical Report. The intent is for the final report to lead to solutions that are well-justified and in the national interest. A wide range of structural and non-structural alternatives will be assessed, using analytically sound methods.

Development of a framework is complicated because of the need to integrate and display different kinds of data simultaneously in a way that can communicate effectively to decision-makers and other non-engineers. It is anticipated that a draft framework that has the utility to begin to inform decisions will be developed by October 2006; it may take longer to populate framework matrices with information.

Analyzing the efficiency and effectiveness of hurricane risk reduction by using the probability of storms and level of risk reduction instead of using a criteria or standards such as Standard Project Hurricane offers a more realistic and understandable approach for engineers, government leaders, and the public. More importantly, it opens up the risk management decision that is primarily treated as an engineering decision in a criteria approach. It facilitates an incremental comparison of risk reduction performance to plan implementation costs, both the cost of construction but also other economic costs. This facilitates open public choice on tolerated residual risks.

Risk-Informed Decision-Making

The Corps has used risk analysis to develop quantitative measures of risks and consequences for flood damage reduction since 1995. The innovation for the LACPR report is extending the use of quantitative risk assessment explicitly to risk-informed decision-making. There are three aspects of this risk-informed decision approach: 1) quantitative risk assessment; 2) scenario planning; and 3) a structured risk-informed decision process. These aspects are described more fully below.

Quantitative Risk Assessment

Risk assessment is the systematic process for quantifying and describing the nature, likelihood and magnitude of risk associated with some substance, situation, action or event, including consideration of relevant uncertainties. The purpose of the assessment is to communicate the risks to all interested parties and to inform decision-makers to make choices on managing the risks. Risk assessment follows the path from an initiating event (e.g., a hurricane), to natural system response (e.g. storm surge level), to the response of the engineered system (e.g., wall overtopping), to the system outcome (e.g., breach formation), to the exposure (e.g., population), to ultimate consequences (e.g., fatalities). Obviously, other influential factors, such as waves, can contribute to engineered system response or mitigated consequences. For each element in the process, there are conditions that can influence the scale, system response and ultimate consequences. For instance, the extent of wetlands can mitigate the storm surge and the forces on the engineered system. Land use regulations can reduce to exposure. The methodology in LACPR will assess all hurricane risk reduction plans using this framework. It will produce quantitative information describing the risks and consequences for various populations, assets and other resources along the coast for the existing condition and for each alternative formulated. These can be compared against the cost of each risk reduction measure in a risk-informed decision process.

The technical development of the quantitative risk assessment approach is one of the products of IPET. It represents the latest and most ambitious application of risk analysis concepts to Corps planning and decision-making. Although it shows promise, the technical aspects of the methodology will need further development by leading experts and a rigorous independent review.

Scenario Planning

The LACPR will augment the traditional Corps planning and evaluation approach by using scenario planning. The goal is to deal more effectively with uncertainty especially where a quantitative assessment of uncertainty is not feasible or appropriate. Traditional Corps' planning methods rely on forecasts of the future with and without a plan in place. These forecasts are treated more or less as a deterministic view of the future. Scenario planning is a purposeful examination of a complete range of futures that could be realized. It is done to address the uncertainty inherent in planning. Unlike forecasts, scenarios do not indicate what the future will look like so much as what the future could look like. Scenario construction stimulates creative ways of thinking that help planners, decision-makers and stakeholders break out of established patterns of assessing situations and plans so that they can better adapt to a rapidly changing and complex future. Consequently, scenarios are most appropriate under conditions where complexity and uncertainty are high.

The first and major thread of scenario planning is developing several without project conditions rather than a single most likely future without a project. This method, developed for strategic planning by industry, recognizes large uncertainties in the future. Different realizations of the future could lead to quite different views about the best actions to take in the present. Uncertainties are addressed by describing different scenarios for each relevant future state of the world both in the "no action" and in all "with project" conditions. Then, rather than selecting a plan based on its differences between a without and with project conditions comparison as the Corps currently does, each plan is evaluated against each of the future scenarios (i.e., the multiple without project conditions and corresponding with project conditions). During this evaluation, the quantitative risk assessment approach is used for each plan and each future. The performance of each plan can be assessed against its cost to reveal the tradeoffs between project outputs and its cost.

Scenario planning acknowledges the critical influence of a few uncertainty drivers on the future condition that provides the base condition for project evaluation. Rather than focus on a single without project condition as the base, scenario planning acknowledges uncertainty by considering an array of futures based on different potential values of key uncertainties. Additionally, scenario planning considers the additional uncertainty of the performance of each plan. In this context, plans are formulated that both address each of the possible futures but also are robust in achieving the desired objectives regardless of the future. These key uncertainty drivers will be identified for the LACPR report injunction with experts and stakeholders. Potential candidates are the rate of sea level rise and the rate of post-Katrina reconstruction. Adaptive management, where appropriate, can be an effective strategy to deal with uncertain future conditions.

Risk-Informed Decision Process

The LACPR final report will support the development of the methodology and incorporate it into a range of information to be presented to decision-makers. Key decision-makers, of necessity, will aid in identifying the objectives and criteria that measure the achievement of those objectives. The objectives and performance measures of each plan in meeting the objectives will be presented in matrix form. Objectives will be such things as increasing environmental benefits, increasing economic output, increasing safety. For each of these objectives performance metrics will be developed such as acres of wetland, net benefits, and number of fatalities. Each of these will include a probabilistic dimension. The analysis will be designed to identify potential risks inside and outside of risk reduction systems and couple it with potential economic, ecosystem, and human health and safety impacts associated with inundation levels.

The matrix will be integrated with GIS for graphical presentation of results in multiple formats including scales of geographic resolution. These will scale from the broadest, coast wide, level through the watershed, political subdivision, levee district, drainage sub-basin, ZIP code, census-tract, and census-block levels. Multiple scenarios will be evaluated including scaled levels of development and recovery and modification of scenarios that would allow for gauging of unknowns such as sea level rise and subsidence variations.

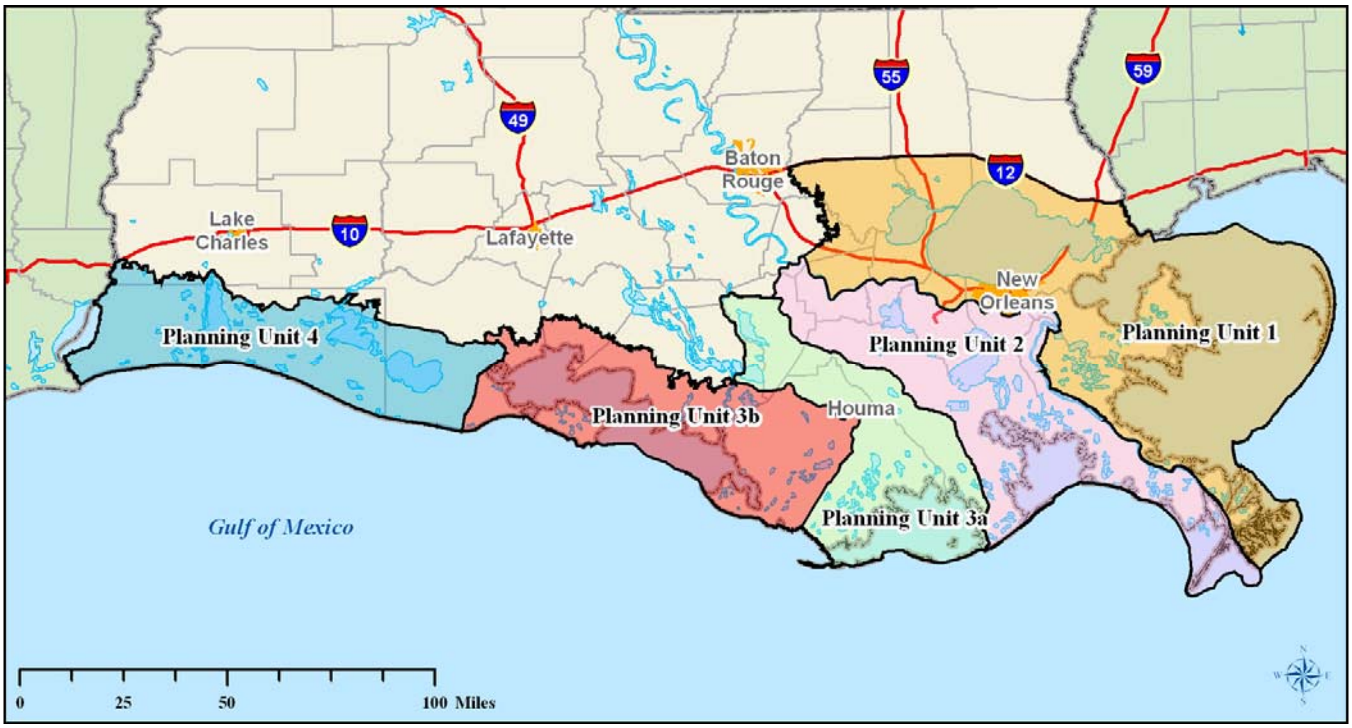
An important part of the risk-informed decision process is conveying information on residual risks. These risks derive from the exposure of people, property, infrastructure, the ecosystem, the local economy, and social and cultural aspects of the region to loss from events that exceed the design. Decision-makers must recognize these residual risks exist and that planning alternatives can rarely, if ever, reduce the likelihood of their loss to zero.

Elements of the Risk-Informed Decision Framework

Geographic Planning Units

The first element of the decision framework is the division of the project area into geographic planning units. The physical landscape behind any proposed feature is comprised of various natural, geomorphic, hydrologic, and political boundaries. Planning units will be watershed-based, but may be subdivided by political boundaries or other factors that are relevant to hurricane risk reduction considerations. These boundaries provide logical lines for subdividing the coastal areas into planning units within which the assets at risk are relatively uniform and for which risk reduction measures can be planned independently of other units.

Geographic Planning Units



To facilitate the subsequent steps of planning, the Louisiana coast was divided into these five planning units which represent coastal hydrologic basins or sub-basins (see figure above). These units also rationalize the coast into more manageable sections and provide a consistency with the breakdown previously used for the Louisiana Coastal Area study and Coast 2050 plan. This breakdown also aids the planning effort by promoting relative consistency in the types of issues and risks in each area. The five planning units are:

1. The area east of the Mississippi River (Lake Pontchartrain Basin)
2. The area from the Mississippi River west to Bayou Lafourche (Barataria Basin)

3a. The area west of Bayou Lafourche to Bayou de West (Eastern Terrebonne Basin)

3b. The area west of Bayou de West to Freshwater Bayou (Atchafalaya River Influence Area)

4. The area west of Freshwater Bayou to the Sabine River (Chenier Plain)

Detailed descriptions of the individual planning units are included in Enclosure A (Sections 2 – 6) along with maps and tabular data.

Assets: What's at Stake

The second element of the decision framework is to identify the assets situated in each of the geographic planning units and relevant subunits. In addition to the traditional NED assets and the calculations used to determine cost and benefits ratios, it is important that the public and policy makers have a clear understanding as to exactly what assets are to be considered for risk reduction measures as well as the matrices that will be used to quantify them. The decision framework will expand on the identification of these assets by describing the relative risk to which they are exposed. There is not sufficient transparency and clarity in traditional cost/benefit calculations to reduce such considerations to a numerical metric. The actual raw data as to what assets are presumed to be in place in each geographic planning unit once risk reduction measures are fully implemented will best inform policy, and this raw data must extend beyond the traditional NED factors to include the following assets:

- Economic assets of national significance
- Economic assets of regional significance
- Environmental assets
- Population and other socially significant assets

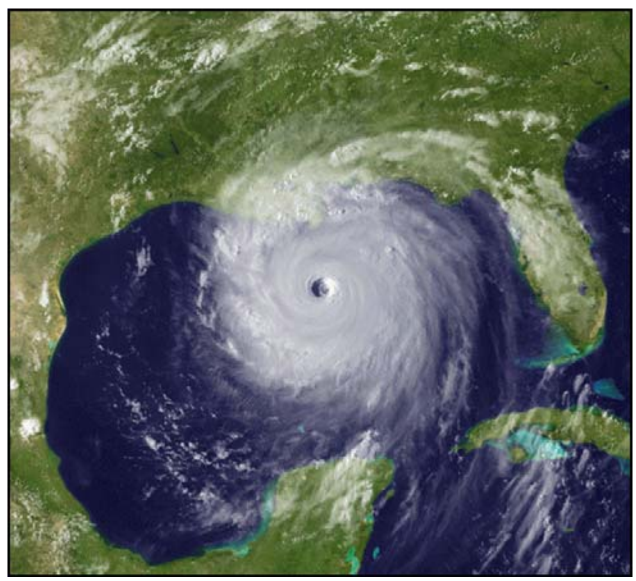
These assets align with the benefit accounts identified for traditional planning evaluation. Decision-makers are likely to find it useful to know not only what particular assets are expected to be in place at the time any structural elements considered for construction might be completed, but also what assets have been in place in the past and in the present, that is, pre-Katrina and post-Katrina, as well as post-construction (which could be a decade or more in the future).

Hurricanes have caused extensive damages to coastal parishes in Louisiana since the time of earliest settlement. Over 40 hurricanes have impacted the coast of Louisiana within the last century. From 1900 to 1950, ten major storms struck Louisiana's coastline killing 671 people. After 1950 the National Weather Service started naming storms and since then, thirteen hurricanes (Flossy, Audrey, Betsy, Camille, Carmen, Juan, Andrew, Georges, Isidore, Lili, Cindy, Katrina, and Rita) have caused destruction, and in some cases, loss of life in Louisiana. A description of the tropical storms and hurricanes that have impacted Louisiana since the 16th century through 2005 is presented in Enclosure B. Since 1950, hurricanes and tropical storms have caused well over $100 billion worth of damage and killed more than 2,000 people in Louisiana. In 2005, Louisiana experienced two major hurricanes, Katrina and Rita, both of which grew to powerful Category 5 strength as they approached the State's coast.

Hurricane Katrina

Hurricane Katrina, which made landfall near Buras, Louisiana on August 29, 2005, brought widespread devastation and loss of life to areas of the Gulf Coast from Louisiana east to Mississippi and Alabama. Orleans, St. Tammany, Plaquemines, and St. Bernard Parishes suffered in unprecedented ways as floodwaters that had overtopped and breached the protection systems remained trapped behind the levees and floodwalls. Although final damage estimates have not been determined, it is likely that the total economic impact to Louisiana and Mississippi will exceed $150 billion. Some 80% of New Orleans was flooded by Hurricane Katrina's surge. Over 180,000 homes in the New Orleans area were seriously damaged or completely destroyed during this storm event.

Hurricane Katrina Before Landfall



Hurricane Rita

About four weeks after Hurricane Katrina made landfall, Hurricane Rita hit the Gulf Coast of Louisiana near the Texas state line on September 24, 2005 causing significant flooding eastward all the way to New Orleans. Flooding occurred in some of the already heavily damaged areas of Orleans and St. Bernard Parishes. Additional flooding was reported in Slidell and Mandeville in St. Tammany Parish from the high tides in Lake Pontchartrain. Rita's storm surge caused devastating damage all along the Louisiana and southeastern Texas coast. The Mermentau River Basin remained flooded for several weeks after Hurricane Rita passed. Approximately 10,000 structures were flooded and damages exceeded $5 billion. The initial Red Cross estimate of residential units impacted by either Hurricane Katrina or Rita was more than 473,000, including more than 137,000 destroyed.

Additional information about the economic impacts of Hurricanes Katrina and Rita in Louisiana is provided in Enclosure C.

Flooded Homes in Chalmette, LA (East of New Orleans)

South Louisiana at Risk

The damages caused by Hurricanes Katrina and Rita during the 2005 hurricane season revealed the vulnerability of South Louisiana to catastrophic hurricanes. The consequences of a catastrophic hurricane are variable, depending on numerous factors, including the storm's intensity, size, forward velocity, path, and landfall point. Although the return interval for another Katrina-like hurricane has yet to be determined, it is likely that a similar or worse storm will strike the area again. Even in the absence of a rigorous economic analysis, the catastrophic consequences of Hurricanes Katrina and Rita compel prompt actions to protect life, property, and national resources.

Existing hurricane risk reduction projects have been concentrated around areas with high population densities in the southeastern part of the State. As coastal wetland losses continue, the threat of storm surge to populated areas increases.

Impacts of major storms on communities, natural resources, industry, and strategic economic resources are the subject of growing concern. Even if the populated areas located behind existing hurricane risk reduction systems can be made safer through increasing levels of risk reduction, the losses of coastal areas outside of the risk reduction systems pose an increasing threat to the economic and environmental sustainability of the region.

While the most useful information as to assets at risk is to be found in the respective geographical planning units, the following state-wide aggregation of related assets (communities, industries, and coastal resources) is informative.

Multiple Coastal Uses in Louisiana

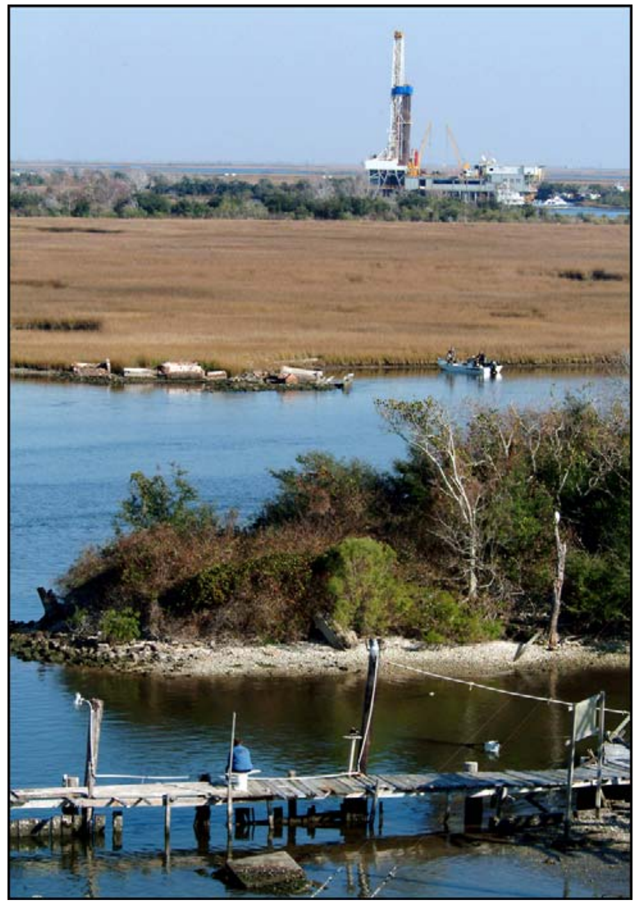


Photo shows oil and gas drilling and commercial/recreational fisheries ongoing in Louisiana's wetlands.

Communities at Risk

Across South Louisiana there are 23 parishes that are subject to various levels of inundation by hurricane storm surges. These coastal parishes contain 55% of the State's population, over 2.4 million people according to a January 2006 Post-Disaster Population Estimates by the Louisiana Department of Health and Hospitals Bureau of Primary Care and Rural Health. Major population centers include the greater metropolitan area of New Orleans, the Houma – Thibodaux area, the Lafayette metropolitan area, and the Lake Charles metropolitan area. In New Orleans alone, assets total more than $500 billion of residential and non-industrial properties. Some estimates place a similar value on industrial and public infrastructure resources. Numerous coastal communities outside of the State's population centers are also at risk.

Coastal subsidence, wetlands losses, and relative sea level rise make these coastal communities increasingly vulnerable to inundation from hurricane induced storm surges. As these coastal changes continue, inundation could occur more frequently and at greater depths than experienced in recent history.

Industries at Risk

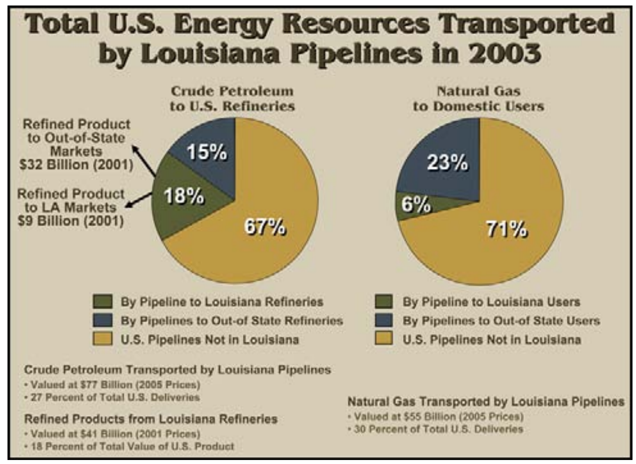
Louisiana has a significant role in the Nation's economic health contributing to over 10% of the United States economy through industries including oil, gas, agriculture, aquaculture, river freight, and tourism. South Louisiana's coastal zone is home to over 75% of the most important industries in the State. Transportation systems in South Louisiana include the Gulf Intracoastal Waterway, the Mississippi River, deepwater ports, railways, highways, and airports, all of which are critical to regional, national, and international trade. Louisiana is also an exporter of sulfur, salt, forest products, agricultural products, chemicals, and seafood. Coastal Louisiana provides an integral national security function by supporting energy independence, balance of trade, military bases, defense construction, and the efficient and effective transportation of commodities.

Ports

Economic facilities in South Louisiana supporting the oil and gas industry include seven deep water ports (the Port of New Orleans, the Port of Lake Charles, the Port of Baton Rouge, the Port of Morgan City, the Port of South Louisiana, the Port of Plaquemines, and Port Fourchon). This network of port facilities near the Gulf of Mexico and on the Mississippi River forms a critical hub for international trade and represents the largest deep draft shipping complex in the world. The combination of waterborne commerce, trunkline railroads, highways, and trucking connections accommodate the movement of grain, petroleum, natural gas, and a wide range of other products important to both national and international commerce. The Port of South Louisiana is the fourth largest port in the world in terms of tonnage, and among the largest U.S. ports for several major commodities including cement and coffee.

Petroleum Industry

Oil, gas, and petrochemicals represent Louisiana's largest industry. South Louisiana ranks number one and number two in the Nation for oil and natural gas production. The energy sector is heavily dependent on oil and gas exploration, production, and petrochemical refining along the coast of Louisiana. Approximately 25% of the Nation's oil production originates in Louisiana and adjacent Federal waters. In addition, Louisiana is home to many strategically important energy production, pricing, and distribution locations including the Strategic Petroleum Reserve, the Henry Hub Natural Gas Trading Point, Louisiana Offshore Oil Port, and Port Fourchon Deepwater Exploration and Production Supply Base.



(Source: U.S. Department of Energy and the Louisiana Department of Natural Resources)

Oyster Boat Working in Louisiana Coastal Waters

Commercial Fisheries

The National Marine Fisheries Service reports that 2004 fish and shellfish landings in Louisiana represented approximately 11% of the U.S. total. In 2004, Louisiana commercial landings exceeded 1 billion pounds with a dockside value of approximately $275 million. In 2003 and 2004, three out of the top 10 commercial fishery ports in terms of pounds were located in coastal Louisiana.

Tourism

The Louisiana Travel Promotion Association has reported that tourism is the second largest industry in Louisiana generating $9 billion in expenditures, attracting over 21 million visitors annually, and providing employment for approximately 120,000 residents. Louisiana is home to many attractions such as the French Quarter, plantations, Cajun country, and world class outdoor activities. The coastal wetlands support a sport hunting industry of $446 million. Recreational saltwater fishing can bring in up to $1.2 billion per year.

Medical Industry

The 2002 Economic Census of the U.S. Census Bureau reported that 187 hospital facilities were located in Louisiana, along with another 7,377 ambulatory health care services such as offices of physicians, outpatient care facilities, and home health care facilities, and 896 nursing and residential care facilities. Total receipts exceeded $17 billion with a total payroll of about $6.5 billion. More than 170,000 people were employed at these facilities statewide. Two of the State's three medical schools are located in New Orleans. Approximately 45% of the State's establishments for ambulatory health care services are located in the New Orleans metropolitan area, along with 39 hospitals and 240 nursing care facilities. Many of these facilities were damaged or destroyed during Hurricane Katrina.

Shipbuilding

As of 2002, more than 100 ship and boat building companies were located in Louisiana, employing 13,859 people with payrolls totaling more than $425 million. Total shipments exceeded $1.9 billion, including more than $900 million added by manufacturing. The companies range in size from small businesses with one or two employees to large corporations. Northrop Grumman, with approximately 6,000 employees, is one of the largest private employers in the State and is located in the New Orleans metropolitan area.

Louisiana's Unique Coastal Resources at Risk

Louisiana coastal wetlands, built by the deltaic processes of the Mississippi River, contain an extraordinary diversity of habitats that range from narrow natural levee and beach ridges to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. Taken as a whole, the habitats from the upland areas to the Gulf of Mexico, with their hydrological connections to each other, and migratory routes of birds, fish, and other species, combine to place the coastal wetlands of Louisiana among the Nation's and world's most productive and important natural assets. Additional information about

South Louisiana's unique and important coastal environment is provided in Enclosure D.

The coastal wetlands are also important habitats for small resident fishes and shellfishes such as least killifish, rainwater killifish, sheepshead minnow, mosquitofish, sailfin molly, grass shrimp, and others. These species are typically found along marsh edges or among submerged aquatic vegetation, and provide forage for a variety of fish and wildlife. Coastal marshes within the levee risk reduction areas also provide nursery habitat for many estuarine-dependent commercial and recreational fishes and shellfishes. Because of the protection and abundant food afforded by those wetlands, they are critical to the growth and production of species such as blue crab, white shrimp, brown shrimp, Gulf menhaden, Atlantic croaker, red drum, spotted seatrout, black drum, sand seatrout, spot, southern flounder, striped mullet, and others. Those species are generally most abundant in the brackish and saline marshes; however, blue crab, Gulf menhaden, Atlantic croaker, and several other species also utilize fresh and low-salinity marshes. The Eastern oyster occurs throughout brackish marshes in South Louisiana and supports commercial fishery.

Coastal wetlands provide nursery and foraging habitat that supports economically important marine fishery species such as spotted seatrout, southern flounder, Atlantic croaker, gulf menhaden, striped mullet, and blue crab. These species serve as prey for other Federally managed fish species such as mackerels, snappers, groupers, billfishes, drum, and sharks. Essential Fish Habitat, or those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity, encompasses all the wetlands and the bays along the Louisiana coast and is an important consideration in the development of any hurricane risk reduction and coastal restoration plans.

Hurricanes impact the coast not only through the damages to communities and industries but also through the destruction of coastal features such as wetlands, ridges, forests, and barrier islands. These coastal features form the State's first line of defense against hurricanes. Wetlands also provide important fish and wildlife habitat and serve as natural buffers between coastal communities and the open Gulf of Mexico.

Louisiana Blue Crabs

Fort Proctor on Lake Borgne

Fort Proctor (a.k.a. Fort Beauregard) was built in the 185's as part of fortifications to protect New Orleans. Originally constructed on land, the fort now lies in Lake Borgne due to coastal erosion.

Wetland Losses

Approximately 30% of coastal marshes found in the continental United States are located along the Gulf Coast of Louisiana. In 1932, there were approximately 7,025 square miles of coastal wetlands in Louisiana. By the year 2005 and pre-Hurricane Katrina, coastal wetland losses totaled approximately 1,900 square miles of the 1932 estimated coastal wetland coverage.

As demonstrated by Hurricanes Katrina and Rita, storm surges in the Louisiana coastal environments can directly cause significant wetlands losses. Post-Hurricane Katrina and Rita impact evaluations revealed an additional coastal wetland loss estimated at more than 217 square miles. This 2-day loss exceeds the wetland losses that were projected to occur over a 20-year period. By the year 2050, it is estimated that another 513 square miles of coastal wetlands will be lost for a total projected wetland loss during the time period of 1932 to 2050 of approximately 2,532 square miles of wetlands (or 36% of the 1932 coastal wetland landscape). In many cases, losses of coastal wetlands have exposed or will expose coastal communities to direct high wave energy from the Gulf of Mexico during storms.

Environmental and Ecosystem Impacts

A catastrophic hurricane holds the potential for severe environmental costs associated with inundation of coastal Louisiana metropolitan areas and industries. A storm surge in these areas could cause significant environmental damage and cleanup could take years. Untreated sewage and household chemicals would further impact the environment. Garbage and refuse created by the storm would have to be disposed in landfills or burned, with resulting environmental impacts. Petroleum and chemical plants could be damaged, and the resulting hazardous spills would not only affect populated areas but also could be released into fragile coastal ecosystems surrounding these areas.

Development and Assessment of Risk

Using the planning units that were identified earlier, the LACPR team collated critical baseline information on areas possessing identifiable value and risk. This information was compiled into two categories: economic assets and environmental assets. Existing analyses were also available to support an initial projection of future conditions, Step 2 of the plan formulation process. The processing of this asset information relative to the principles and objectives allows identification of key areas of risk and potential measures to reduce or eliminate them. A description of the methodology for the development of these assets can be found in Section 1.6 of Enclosure A. Tabular applications of this data are also provided by planning unit, at the back of Enclosure A.

Flooded Wastewater Treatment Plant in City of New Orleans

Assessment of Concentrated and Distributed Economic Assets

The collation of baseline information related to human economic assets was considered in terms of 'Concentrated Assets' (which include communities and other groupings of built assets) and 'Distributed Assets' (such as highways, waterways, and oil and gas facilities). In relative terms, the economic assets which are at risk if no further action is taken to protect them were identified. Review of these assets considered both what the assets are and their present level of flood risk and risk reduction. Loss of storm attenuation (exposing traditional flood risk reduction measures to open Gulf conditions) was also considered.

Assessment of Environmental Assets

The environmental asset review has considered the status of planning units and the processes presenting threats to natural resources (e.g. subsidence, disruptions to natural hydrology). In general the relative influence of major function disruptions on each of the planning units was identified. The natural resources which are at risk if no further action is taken to protect them were also identified. Major habitat types were described, as well as representative fish and wildlife species for each of those habitat types. This information was taken directly from the Coast 2050 report.

Both the economic and environmental asset groups were reviewed relative to consideration of how the Louisiana coast would evolve over the next 100 years under a scenario assuming existing levels of risk reduction are maintained (with repairs to pre-Katrina levels) and those projects authorized for construction funding are completed. Assessment of this baseline or "base plan" condition considered the physical evolution of the coast to forecast its future landscape and hence the implications for environmental and economic assets, respectively. These implications were then used to evaluate the future level of risk to the human assets and evaluate future consequences to natural resources.

The coastwide baseline has been summarized into an overview for each planning unit, presenting the status of the planning unit and its assets. These overviews can be found in Enclosure A.

Washed Out Levee and Road in Plaquemines Parish Destroyed by Hurricane Katrina

Screening Storms

A third critical element of the decision-making framework will be to establish the nature of representative storms for which increased levels of risk reduction are to be considered. The statute identifies one such storm as a "Category 5 hurricane." This terminology is drawn from the widespread use of the Saffir-Simpson Scale, a scale for categorizing hurricane wind damage, for weather forecasting warnings and media reporting to inform the public as to the advisability of evacuation from areas where winds may destroy buildings. It has little utility for identifying the storm surge and wave wash factors that engineers use to design levees and other hurricane risk reduction works. The LACPR report provides an important opportunity to educate the public and reframe an understanding of the kinds of storm characteristics important in the consideration of risk reduction. This improved public understanding of storm dynamics is important to the consideration of a system that will reduce risks from storms with sustained winds greater than 155 miles per hour and storm surge heights exceeding 18 feet.

Analyzing the efficiency of hurricane risk reduction features by using the probability of storms and risk reduction instead of the Saffir-Simpson damage categories offers a more realistic and understandable approach for engineers, government leaders, and the public. The Corps of Engineers IPET and LACPR teams have identified a new risk-based assessment methodology as a key tool for developing hurricane risk reduction plans that would include the kinds of valuation of consequences to populations and assets at risk from storms. The new IPET methodology seeks to transform the development of hurricane risk reduction plans away from a single event-driven planning approach to a more robust risk-based assessment that would provide policy makers with scaled alternatives and consequences to consider for the respective geographic planning units. Storm evaluation criteria used in the report will include a range of design storms and their probability of recurrence stated in years (e.g., a 100-year storm, or a 350-year storm, etc.), and will identify for each of the geographic planning units the worst-case tracks for such storms, considering the geomorphic and hydrological characteristics of that unit.

The LACPR final report will include definition of the characteristics and consequences for two storms that would meet the statutory requirement for assessing storms with sustained winds of 155 miles per hour or greater. It will also provide policy makers with characteristics and worst case storm tracks for these and additional storms. This will provide significant options for consideration in the event that "Category 5" risk reduction is not considered desirable, reasonable, or feasible in a particular geographic area. The principal storm characteristics that create storm surge and wave wash are listed for each of the storms to be considered in the final report, as follows:

- Maximum Possible Hurricane, to include identification as to probability of recurrence stated in years. This storm would have the estimated characteristics of the theoretically most extreme hurricane that could threaten South Louisiana. Weather and hurricane experts are continuing to verify the parameters that could be expected from this maximum possible event.
- Probable Maximum Hurricane (PMH), to include identification as to probability of recurrence stated in years. The PMH is a hypothetical hurricane that might result from the most severe combination of hurricane parameters that is considered reasonably possible in the region involved, if the hurricane should approach the point under study along a critical path and at optimum rate of movement. This storm is substantially more severe than the Standard Project Hurricane, but less severe than the Maximum Possible Hurricane.
    - Maximum Sustained Winds at landfall: 160 MPH
    - Central Pressure: 890 millibars
    - Radius of Maximum Winds: 11 miles
    - Forward Speed: 10 MPH
- Hurricane Katrina, to include identification as to probability of recurrence stated in years.
    - Maximum Sustained Winds at landfall: 127 MPH
    - Central Pressure: 920 millibars
    - Radius of Maximum Winds: 30 miles
    - Forward Speed: 14 MPH
- Other storms as appropriate, based on storm characteristics as to probability of recurrence stated in years, such as the 100-year storm. These storms would define the lower extent of expected risk for any area of the coast.

This concept of identifying a scaled set of alternatives of storms for which risk reduction is to be considered is important for comparative context for decision-making. For instance, the new post-Katrina stronger and better hurricane risk reduction system now authorized and funded for construction in New Orleans will provide risk reduction for a 100-year storm. The massive works put in place in The Netherlands are designed to provide risk reduction from a 10,000-year storm. The Herbert Hoover Dike surrounding Lake Okeechobee is being reconstructed so that it will provide risk reduction for a 935-year event. Unless and until the public and decision-makers have information to make judgments about the most appropriate storm and storm tracks to evaluate for risk reduction analyses, it will be impossible to reach conclusions as to what kind and to what scale such risk reduction works should be recommended for design and construction.

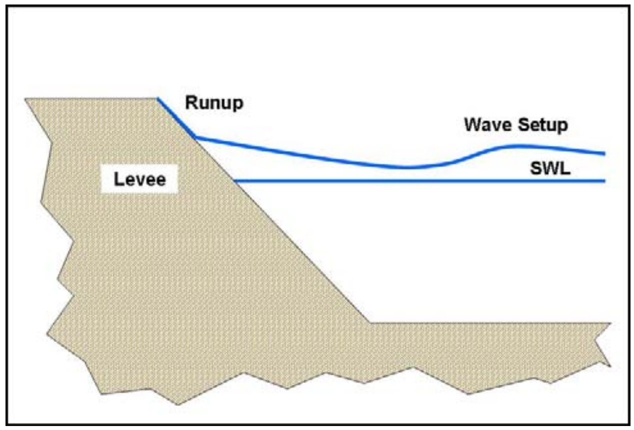
Wind, Waves and Water Workshop

A Hurricane Protection Design Workshop, also referred to as the "Wind, Waves, and Water Workshop" held on December 20 – 21, 2005 in Vicksburg, MS was the first of three technical workshops conducted during the 6-month development of the Preliminary Technical Report. The Wind, Waves, and Water Workshop was held to establish design teams and to discuss issues related to estimating the maximum hurricane for design comparison and analysis. Participants included the Corps of Engineers, National Hurricane Center, Louisiana State University, and other universities including Delft University in The Netherlands. Three screening storms were identified for modeling and analysis: (1) the Maximum Possible Hurricane (2) the Probable Maximum Hurricane and (3) a "Katrina-like" hurricane. The modeling presented in this Preliminary Technical Report used only the Probable Maximum Hurricane. The other two screening storms will be modeled for the Final Technical Report. The LACPR team may also evaluate other screening storms below "Category 5" intensity. A summary report of the workshop is included in Enclosure E.

Engineering and Technical Design Work

Hydrodynamic modeling is being performed for three design purposes: surge and wave modeling to determine required levee heights, coastal modeling to determine how coastal features reduce storm surge, and interior drainage modeling to determine how new levees would impact existing drainage systems. Numerical hydrodynamic modeling and analysis of storm surge and wave forces for the Preliminary Technical Report includes a sampling of some significant storm events on paths likely to impose the maximum loads on the hurricane risk reduction system. These multiple storm tracks were run with each of the five levee alignments developed for modeling purposes. Given the accelerated project schedule, engineers have continued to develop preliminary schematic designs for an array of levees and structures along each of the five levee alignments even though the results from hydrodynamic modeling are not finalized.

Wave Runup on Slope-Faced Levees



Wave runup for major storms can be substantial; some preliminary calculations indicate as much as 12 feet of runup. Although flatter fronting slopes reduce the wave runup on levees, they require more material to build and a larger footprint in environmentally sensitive areas. A thorough analysis is needed to optimize the design and find the ideal fronting slope or other means for reducing wave runup for each levee reach.

Similarly, a comprehensive analysis of erosion protection systems will be needed. Breaking waves generated by hurricane-force winds will require a system to withstand tremendous forces. Fortunately, a great deal of research has already been conducted and a large variety of commercially produced and test products are available. The engineering team will develop the most advantageous design for each reach and loading condition. These and other more detailed and optimization analyses will be part of the Final Technical Report.

Damaged Floodwall along the MRGO

Inspection of a damaged floodwall along the MRGO showing scour on the protected side caused by storm surge overtopping the structure.

Field Data Collection

The Preliminary Technical Report was completed with data on-hand. Existing Light Detection and Ranging (LIDAR) surveys of South Louisiana were used to determine ground elevations along several proposed alignments. Available soil boring and testing data were used to develop four typical foundation soils to be used in the preliminary design of levees and structures. Data collection for the Final Technical Report will be more extensive as required to provide more detailed analyses. Soil borings are planned throughout the project area to fill in voids in existing data sets. Surveys will be conducted of channels and other areas that can not be described in adequate detail using existing information.

Surge and Wave Modeling

Hydrodynamic modeling of storm surge and waves for this report was conducted to predict wave action at and water level response to five modeled levee alignments for input to engineering and design to assist in determination of preliminary levee height requirements. Due to time constraints on the Preliminary Technical Report, a single screening storm (i.e. the Probable Maximum Hurricane) was selected and simulated on ten separate, critical tracks. A more comprehensive modeling assessment will be performed for the Final Technical Report. These additional model runs will include simulations across the coast for screening storms covering the Maximum Possible Hurricane and a storm similar to Hurricane Katrina. Additional information on the characteristics of these storms and their application to alternatives development and engineering approaches is provided in Enclosure F.

Although ten storm tracks do not provide the comprehensive coverage needed to define water levels everywhere along the alignments, the modeling results are augmented with engineering judgment to provide reasonable estimates for design purposes. The hydrodynamic response of the system with each proposed levee alignment is also compared to the existing condition to assist in the determination of unintended water level changes created by the proposed structures.

Storm surge modeling was accomplished using the ADCIRC hydrodynamic computer model. ADCIRC is a highly advanced program that recreates the real world storm surge produced by hurricanes as they approach coastal areas. The model storm was run on the supercomputer at the Engineer Research and Development Center (ERDC) in Vicksburg, MS. Utilizing up to 64 computer processors simultaneously, storm model runs simulated from 4 to 10 days of a hurricane's journey across the Atlantic Ocean and the Gulf of Mexico. The numerical model utilizes a digital grid consisting of about 380,000 points. As the model storm approaches the coast, water levels, wind effects and other critical data are calculated for each point. Just one run of one storm track can take up to 24 hours to process on a high performance computer.

Initial Screening Storm

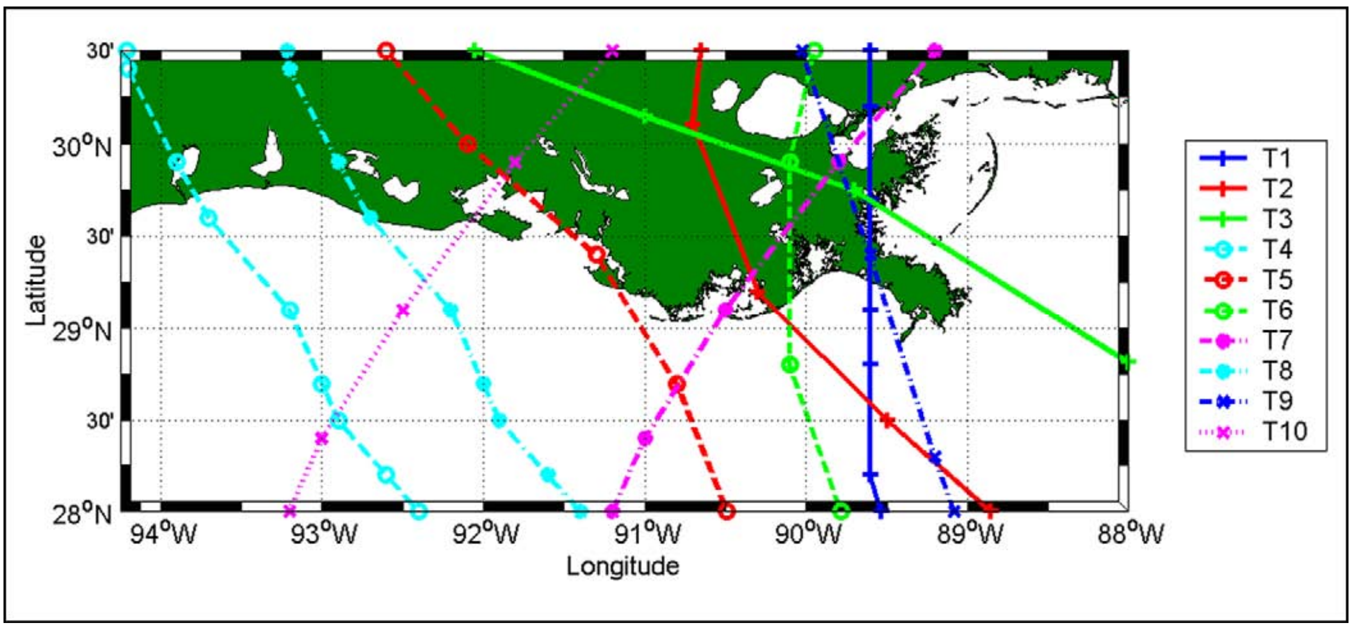
The storm selected for rough order of magnitude design of the five model alignments is based on the Probable Maximum Hurricane (PMH) as documented in NOAA's Technical Report NWS 23 (1979). The PMH has a central pressure of 890 millbars. The PMH criteria for the Louisiana coast describe a storm of "Category 5" intensity on the Saffir-Simpson Scale. The radius to maximum winds was approximately 11 nautical miles, similar to that of Hurricane Camille, and the average forward speed applied for the dynamic solution was set at 10 knots.

Modeled Hurricane Tracks		
Track	Description	Naming Convention
1	Hurricane Katrina	T1
2	Hurricane Andrew shifted 1.0 deg east	T2
3	1947 storm shifted 0.25 deg south	T3
4	Hurricane Rita	T4
5	Hurricane Carmen	T5
6	1915 storm	T6
7	1893 storm shifted 0.5 deg west	T7
8	Hurricane Rita shifted 1.0 deg east	T8
9	Hurricane Camille shifted 0.5 deg west	T9
10	1893 storm shifted 2.5 deg west	T10

The PMH was run on ten historical (or modified historical) storm tracks, deemed to be critical, with landfalls across coastal Louisiana with different approach angles. For storm surge modeling, the storms were translated both at the historical hurricane track speed and at a constant 10 knots. The tracks were selected to result in "Category 5" hurricane surge values at locations across the proposed structural alignments.

Storm surge is a function of many factors including, but not limited to, wind speed, forward speed, landfall location, orientation of the storm track at landfall to the shoreline, central pressure and storm size. Therefore, there is a need to move away from an event-driven approach that considers only particular storms and move towards a risk-based approach, as described in the section titled "Risk Assessment," that addresses how often assets and populations become inundated and how severe that inundation is for storm events with particular characteristics. Such an approach will be considered for the Final Technical Report. A summary of the surge and wave modeling methods and results are presented in Enclosure F.

Selected Hurricane Tracks



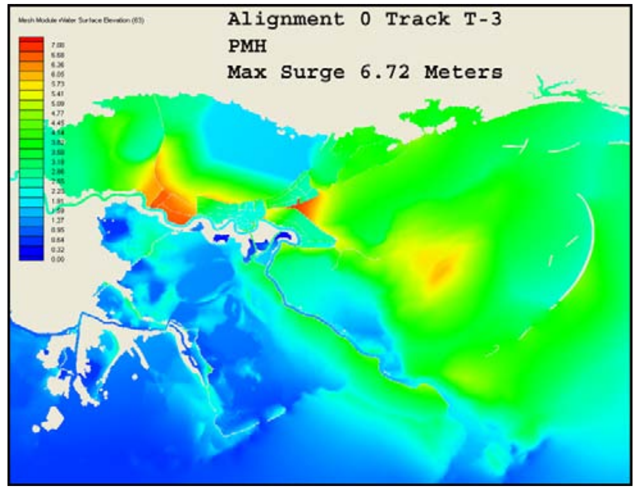
Estimated Maximum Waves, Water Level and Runup

Maximum surge elevations along the five modeled levee alignments range from approximately 13 to 20 feet in Lake Pontchartrain to about 30 to 40 feet elsewhere along the coast. Peak wave periods range from 8 to 14 seconds. For the PMH storm, opening the tidal passes decreases surges on the levee at the Pontchartrain land bridge by about 3 feet and increases water levels in the Lake by about 1.5 feet. It should be noted, however, that the impact of allowing the tidal passes to remain open could increase water levels further in Lake Pontchartrain for larger, slower moving storms and additional analysis is required. Opening Barataria Basin (Model Alignments 3 and 4) reduces surge elevations along the levees by several feet but requires substantially longer levees. Smoothing the high levee alignment (Model Alignment 5, which leaves existing levees not included in the increased risk reduction alignment at the authorized height) reduces the maximum surge elevations east of the Mississippi River by approximately 3 feet. A summary of the maximum wave and surge levels applied for the required crest heights for several levels of risk reduction is provided in Enclosure F.

Changes from Existing Condition

In the existing condition (Alignment 0), levees currently in place are overtopped by the PMH storm simulations. The inundation map below depicts the model results for the PMH storm run on the T3 track, which resulted in a maximum storm surge of approximately 22 feet. The placement of a high levee increases surge elevations by as much as 15 feet for the simulated PMH storm at the ten hurricane tracks. The blocked waters rise on the levee and spread along the levee where possible. For the PMH screening storm, the preliminary model results predict water levels increase less than one foot along the Mississippi coast due to the presence of the alignments modeled. However, the impact to Mississippi could be greater for storms with a larger radius to maximum winds (such as Hurricane Katrina) and additional analysis is required.

Storm Surge Inundation Map



Inundation map for existing conditions showing maximum surge height of 22 feet (Elevations are shown in meters, multiply by 3.28 to convert to feet).

Aerator Fighting Pollution on 17th Street Canal

The Corps of Engineers employed aerators during the unwatering of New Orleans after Hurricane Katrina. These devices helped maintain oxygen levels in stormwaters discharged into Lake Pontchartrain as an environmental safeguard.

Measures and Strategies

The fourth, fifth, and sixth elements of the decision framework are the coastal restoration measures, structural measures, and non-structural measures, respectively, that must be identified and evaluated for hurricane risk reduction potential. Before identifying any new measures, the baseline conditions must be established. This section begins with a description of the existing hurricane risk reduction and flood control projects and studies in coastal Louisiana. The three types of measures are described later in the section along with the process for assembling alternative plans.

Hurricane Risk Reduction and Flood Control Projects and Studies

Numerous hurricane risk reduction and flood control projects, plans, and studies have been completed for areas in coastal Louisiana over the past 40 years. LACPR modeling efforts are integrating all existing conditions along the coast including current hurricane risk reduction projects and emergency repairs performed by Task Force Guardian and other Corps of Engineers teams. The LACPR team has outlined a vision for success that employs a multiple lines of defense strategy, which will incorporate as many of the existing hurricane risk reduction project components as possible into an integrated plan.

The first Federal project to address the problem of hurricane-induced flooding in Southeast Louisiana was the Lake Pontchartrain, LA project authorized by Congress in the Flood Control Act of 1946. This project, completed in 1965, was designed to protect Jefferson Parish from storm-induced flooding from Lake Pontchartrain for 30-year frequency storms. That same year Hurricane Betsy hit the New Orleans area, causing more than $8 billion of damage (in 2002 currency value) and the loss of 75 lives. Since that time, Congress has authorized additional projects at various locations in Southeast Louisiana to develop a more comprehensive hurricane risk reduction program. No hurricane risk reduction projects have been authorized west of the Morgan City and Franklin areas in Louisiana. Although the existing projects have provided substantial hurricane risk reduction and flood control to areas of high-density population in the southeastern part of the State, they are not designed to protect against the full range (or highest level) of storm surges that could be produced by Category 3, 4 or 5 hurricanes.

Because of damages caused by Hurricanes Katrina and Rita, Congress has authorized and appropriated funds for advancing major construction to completion on the existing hurricane risk reduction projects. The Preliminary and Final Technical Reports will assume that all of these improvements will be in place when analyzing the impacts of any proposed recommendations. Many of the existing hurricane projects and much of the ongoing emergency work will become a part of any future enhanced level of risk reduction. In many cases the existing system may function as a secondary line of defense thereby reducing risks to major population centers.

Hurricane Risk Reduction and Flood Control Projects

Hurricane Risk Reduction Project Name	Level of Risk Reduction	Project Completion*
Lake Pontchartrain, Louisiana, and Vicinity, Hurricane Protection Project	Standard Project Hurricane	80%
New Orleans to Venice Project	100-year level of Risk Reduction	84%
West Bank and Vicinity, New Orleans, Louisiana, Hurricane Protection Project	Standard Project Hurricane	38%
Larose to Golden Meadow, Louisiana, Hurricane Protection	100-year level of Risk Reduction	96%
Grand Isle and Vicinity, Louisiana	50-year level of Risk Reduction	100%
Morgan City and Vicinity, Louisiana, Hurricane Protection Project	Standard Project Hurricane	Not yet under construction
Flood Control Project Name	**Level of Risk Reduction**	**Project Completion***
Flood Control, Mississippi River & Tributaries, Mississippi River Levees Project	MR&T Project Design Flood	93%
Flood Control, Mississippi River & Tributaries, Atchafalaya Basin, Louisiana	MR&T Project Design Flood	95%

**As of August 29, 2005*

Hurricane Risk Reduction and Flood Control Studies

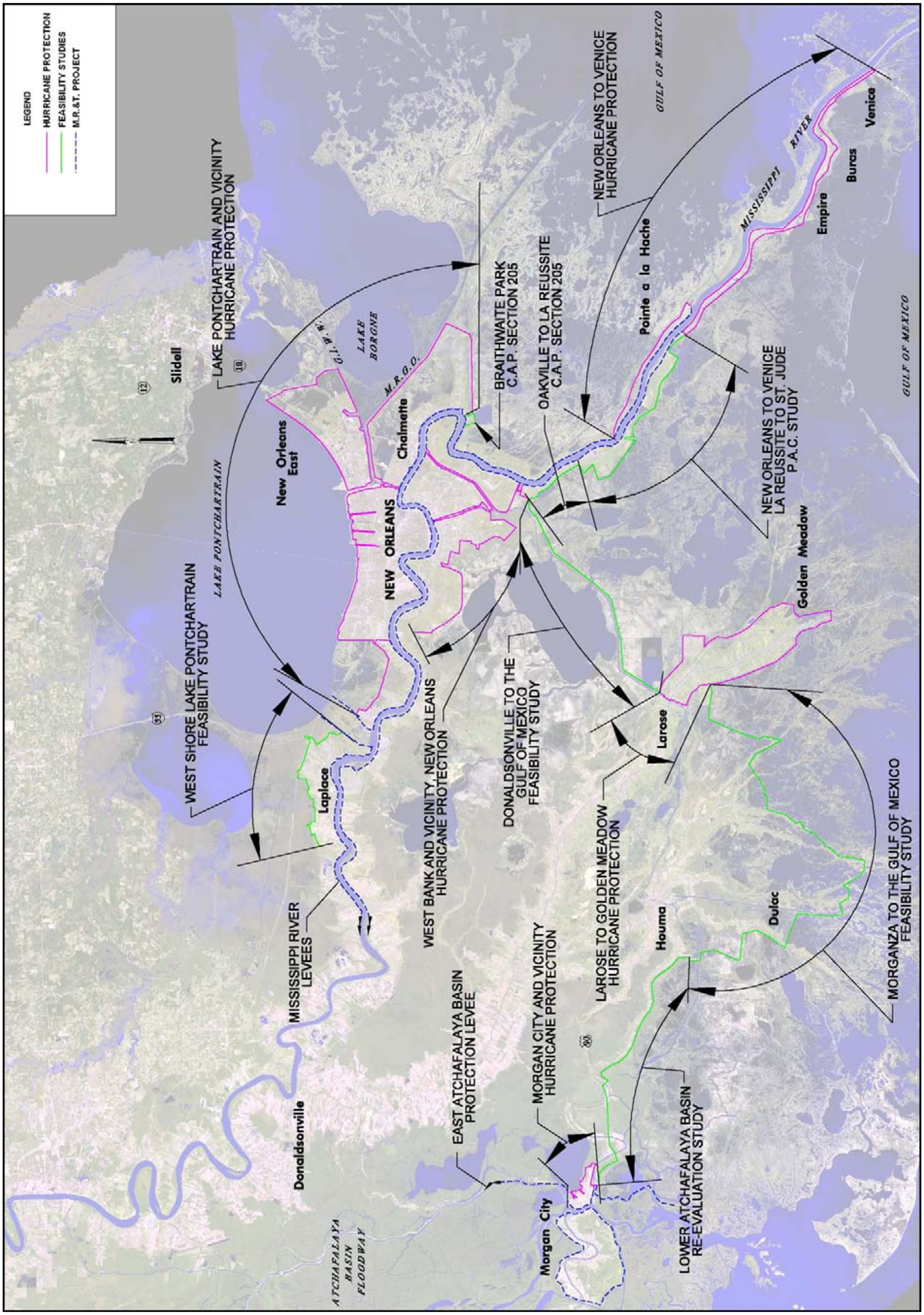
Hurricane Risk Reduction Study Name	Level of Risk Reduction
West Shore – Lake Pontchartrain	To be determined
Braithwaite Park, Louisiana, Continuing Authorities Program Section 205	50-year level of Risk Reduction
New Orleans to Venice, Louisiana, Post Authorization Change Study, La Reussite to St. Jude	100-year level of Risk Reduction
Oakville to La Reussite, Louisiana, Continuing Authorities Program Section 205	50 to 100-year level of Risk Reduction
Southwest Louisiana Hurricane Protection Reconnaissance Study	To be determined
Flood Control Study Name	**Level of Risk Reduction**
Flood Control, Mississippi River & Tributaries, Donaldsonville, Louisiana, to the Gulf of Mexico, Hurricane Protection Study	To be determined
Flood Control, Mississippi River & Tributaries Morganza, Louisiana, to the Gulf of Mexico, Hurricane Protection Study (feasibility complete)	100-year level of Risk Reduction
Flood Control, Mississippi River & Tributaries, Atchafalaya Basin, Louisiana, Lower Atchafalaya Basin Reevaluation Study	To be determined

Emergency Repairs to Damaged Inner Harbor Navigation Canal Floodwall

Although construction of the Inner Harbor Navigation Canal T-wall proceeded at a rapid pace to restore protection for Orleans and St. Bernard Parishes after Hurricane Katrina, parts of the city and region remain vulnerable to large storms.

In addition to the Mississippi River and Tributaries (MR&T) flood control projects, local drainage is controlled by the Southeast Louisiana Urban Flood Control Project (SELA). In Jefferson and Orleans Parishes, SELA generally provides flood risk reduction on a level associated with a 10-year rainfall event, while reducing damages for larger events. The level of risk reduction for St. Tammany projects varies. Studies on urban flood control are also underway in St. Bernard, St. Charles, St. John the Baptist, and Plaquemines parishes.

The Corps of Engineers completed emergency repairs to 169 miles of levees and floodwalls damaged or destroyed during Hurricane Katrina. This work, carried out by Task Force Guardian, restored the hurricane risk reduction system to pre-storm authorized levels. Additional work approved by Congress is being implemented to advance other projects to completion by September 2007. Other hurricane risk reduction work in Louisiana was recently authorized by Congress in emergency authorization bills for storm recovery. The LACPR team is including all of these emergency repairs as part of the existing conditions to be considered in evaluating needs for upgrading the risk reduction to "Category 5" levels.



Existing Hurricane Risk Reduction Studies in Southeast Louisiana

Performance Evaluation of the New Orleans Hurricane Risk Reduction System

Following Hurricane Katrina, the Chief of Engineers tasked the Interagency Performance Evaluation Task Force (IPET) "to provide credible and objective scientific and engineering answers to fundamental questions about the performance of the hurricane risk reduction and flood damage reduction system in the New Orleans metropolitan area." The key objective of the IPET was to understand the behavior of the New Orleans hurricane risk reduction system in response to Hurricane Katrina and assist in the application of that knowledge to the reconstitution of a more robust system. As such, the IPET analysis was geared to determine why certain sections and structures were overtopped and breached and to use that understanding to both assess the integrity of the remaining portions of the system and to assist in designing more resilient risk reduction measures. IPET also conducted a risk and reliability assessment of the entire system to aid in understanding the levels of risk reduction that will exist for the future.

Although the IPET work was conducted separately from the LACPR project, the results of the IPET study are a resource for the LACPR project as it moves toward the Final Technical Report. This section of the report describes the information from IPET activities that will be incorporated into the final LACPR project. The current version of the IPET report with results is available at https:\\IPET.wes.army.mil.

The IPET Study

The IPET study has sought to answer five major questions:

- **The Hurricane Risk Reduction System:** What were the design criteria for the pre-Katrina hurricane risk reduction system, and did the design, as-built construction, and maintained condition meet these criteria?
- **The Storm:** What were the storm surges and waves used as the basis of design, and how did these compare to the storm surges and waves generated by Hurricane Katrina?
- **The Performance:** How did floodwalls, levees, pumping stations, and drainage canals, individually and acting as an integrated system, perform in response to Hurricane Katrina, and why?
- **The Consequences:** What have been the societal consequences of the Hurricane Katrina damage?
- **The Risk:** Following the immediate repairs, what will be the quantifiable risk to New Orleans and vicinity from future hurricanes and tropical storms?

The Hurricane Risk Reduction System

IPET has compiled a comprehensive description of the physical characteristics of the hurricane risk reduction structures pre-Katrina including the hurricane risk reduction system design and built specifications. The geodetic reference datum for Southeast Louisiana has also been updated to provide an accurate reference for all hurricane risk reduction structures. This information is an important verification of existing conditions and will be helpful in forming the basis for design comparisons.

The Storm

Characterizing Hurricane Katrina involved both regional and high-resolution modeling of the surge and waves generated by the storm. The regional modeling provided a perspective of the surge and wave environments for all locations around the hurricane risk reduction system. The high-resolution hydrodynamic modeling focused on creating a more accurate representation of these water levels and forces in the confined areas of the drainage canals, the Inner Harbor Navigation Canal, and the Gulf Intracoastal Waterway. A time history of water level conditions and the resultant forces was essential to describing the hydrodynamic conditions that existed during Katrina.

The Performance

Understanding how the risk reduction structures, interior drainage, and pumping stations performed independently and as an integrated system during Katrina was critical. Detailed information was gathered about the geotechnical conditions, erosion assessments, and heights of levees and floodwalls to determine the breaching mechanisms and to contrast breach behavior at similarly characterized non-breach sites. Results of these efforts will be instrumental in determining approaches to reducing vulnerability to breaching mechanisms in the future. IPET also has compiled information about the pumping stations and history of their performance during Katrina. This information will be used to develop performance curves for modeling de-watering capabilities and evaluation of pump station contributions to hurricane risk reduction.

The Consequences

IPET modeled the flooding resulting from overtopping and breaching of levees. The direct and indirect losses due to that flooding are necessary to develop an understanding of the consequences of Katrina-related flood damage. IPET used existing hydrologic and hydraulic models and incorporated pump station performance and levee failure to develop interior drainage models. These models provided the resultant interior flooding modeled for a variety of storm and hurricane risk reduction system structure scenarios. Additionally, IPET determined the likely extent of flooding and losses if there had been no catastrophic breaching of the hurricane risk reduction system. The information relating flooding and potential losses has supported the risk and reliability analysis and provided products like stage versus loss curves or stage versus damage relations at a fine geographic level (i.e. ZIP code).

The Risk

IPET modeled the risk and reliability of New Orleans and Southeast Louisiana to future hurricanes and tropical storms with the immediately repaired hurricane risk reduction system. Data from direct economic and life loss, and from the comprehensive characterization of levees, floodwalls, and other hurricane risk reduction structures, formed the base model input for the risk and reliability model. Fragility curves by locale and structure for a wide variety of hurricane risk reduction system components provided the probability of failure related to water elevations. This approach will be repeated for a wide variety of potential storm scenarios to assess the value (reduced risk) of alternative risk reduction approaches or alternative levels of risk reduction.

17th Street Canal Sheet Pile Pull – New Orleans, Louisiana

Following Hurricane Katrina, the Corps of Engineers undertook an unprecedented engineering evaluation of the design, construction, and performance of the New Orleans hurricane protection system. In this photo, commanders, engineers, and independent inspectors measure sheet piles removed from near the breach along the 17th Street Canal in New Orleans.

Process for Developing Alternative Plans

The work of policy makers and legislators requires alternatives. The formulation of plans for coastal risk reduction and risk reduction is being undertaken as a joint effort by the Federal and State teams. The formulation process through which existing knowledge and understanding of the Louisiana coast is being used to develop alternative plans integrating hurricane risk reduction, flood control, and coastal restoration is depicted below. This process is built upon the basic formulation process steps traditionally applied in water resources planning. The LACPR effort will document the process objectively, so that all decisions regarding the selection of projects to be recommended for further design analysis or construction are fully documented and well supported. The six planning steps are as follows:

1. Identifying problems and opportunities.
2. Inventorying and forecasting conditions.
3. Formulating alternative plans.
4. Evaluating alternative plans.
5. Comparing alternative plans.
6. Selecting a plan.

Planning and Design Workshops

Step 1 of the planning process specifies the water and related resource problems and opportunities associated with the Federal objective and specific State and local concerns. Many of these problems were revealed by previous studies and by the devastating impacts of Hurricanes Katrina and Rita.

Step 2 develops the inventory, forecast and conditions as they would exist in the absence of any federally supported and funded planning alternative. The purpose of this step is to gain a baseline understanding of the problem using existing information. This second step was initiated by bringing the LACPR and CPRA teams together with local, national, and international technical experts as well as members of the public. Three workshops were held to collect and review the best approaches and the best available information and technologies for use in formulating and designing alternative plans to provide for coastal restoration plans with coastal risk reduction systems through "Category 5." These workshops included the two listed below as well as the "Wind, Waves, and Water Workshop" described in Part 5 of this report.

Initial Plan Formulation Workshop

Step 3 of the planning process is the formulation of alternative plans. Alternative plans are formulated in a systematic manner to ensure that all reasonable alternatives are evaluated. The Plan Formulation Workshop held on February 13 -14, 2006 in Lafayette, LA was attended by over 100 participants from across coastal Louisiana. This workshop provided a valuable initial input step in the formulation of alternative plans. More than 125 coastal restoration and risk reduction ideas were offered, both structural and non-structural, including levees, marsh creation, freshwater diversion, barrier island restoration, and shoreline risk reduction. This workshop was one of the early opportunities for public outreach and involvement and coordination with local governments. Coastal risk reduction alignments were developed from input received at the workshop. Five levee alignments were synthesized from the results for modeling storm surge and wave runup. The full summary report is included in Enclosure G.

LACPR Plan Formulation Workshop in Lafayette, Louisiana

Engineering Technical Approaches and Innovations Workshop

An Engineering Technical Approaches and Innovations Workshop was held at the Engineer Research and Development Center (ERDC) in Vicksburg, MS, on March 2 - 3, 2006. More than 100 geotechnical and structural engineers and experts from industry, academia, and government agencies participated in the workshop. Participants came from across the U.S., Sweden, France, and Great Britain, as well as official visitors from The Netherlands. The workshop produced a variety of recommendations on the cost-effective construction of hurricane risk reduction barriers in South Louisiana. These recommendations included the use of deep soil mixing, geofoam blocks, pop-up barriers, lightweight fill, hollow-core precast concrete sections, and geogrid. For the Preliminary Technical Report, only the improvement of in situ foundation soils using deep soil mix columns was examined.

The Project Delivery Team will continue to review, study, and evaluate recommendations from the workshop as the project progresses. Some of the participants from the workshop may be engaged to lend their expertise to advance suggested plans into schematic designs. More options will be explored and presented in detailed analyses in the Final Technical Report. Enclosure H contains a full summary of the workshop.

Planning Principles and Objectives

Plan formulation is being undertaken as a joint Federal/State effort. The objective of the plan formulation effort is not that the recommended plans will be identical, but that they will be complementary and not contradictory. The principles and objectives developed in Step 1 of the planning process formed the basis for processing initial input information and proceeding through the remaining steps.

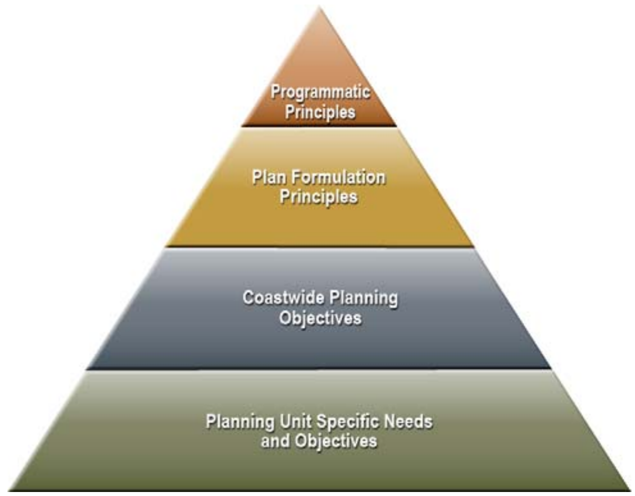
Programmatic and Plan Formulation Principles

The process of developing alternative plans began with identification of principles to provide fundamental guidance for the effort. The State directive, in identifying broader plan requirements, was used as a basis for setting these principles. The principles define the full extent of the range of value-based considerations that should be applied in establishing alternative plans. In doing so, they build on the legislative directives and exceed the basic NEPA requirement of simply avoiding or minimizing impacts. Many of the principles defining environmental-related considerations are derived directly from those developed for the LCA Ecosystem Restoration Study. Additional principles were identified that define the considerations associated with risk reduction of coastal economic and environmental assets and the ability to balance and sustain current uses with improved risk reduction.

These principles define a broader set of subcomponents of those common fundamental objectives found in the State and Federal directives. They also aid in the identification of assets and risks in the landscape and support the definition of planning objectives that indicate levels of success. Programmatic principles identify the critical manners in which implemented plans and measures may ultimately interrelate with and alter the activities and assets within the coastal landscape. They describe the range of critical considerations required to develop appropriate and effective plans and plan components.

Plan formulation principles identify the necessary considerations for identifying potential measures and overall coastal risk reduction plans. They address the definition of potential measures, potential constraints for development of plans, possible limitations in application of types of measures, and provide guidance on how these factors should be addressed.

Hierarchy of Planning Principles and Objectives



Coastwide Planning Objectives

The coastwide planning objectives provide a basic set of desired end states for which either qualitatively or quantitatively measurable parameters can be identified. These objectives provide the basis for measuring the relative success of any alternative plans or measures. In addition they provide a range of values that allows each measure and plan to be gauged versus the principles and the objectives as expressed in the State and Federal directives.

Like the programmatic and formulation principles, the coastwide planning objectives were built upon the LCA Ecosystem Restoration Study to gauge environmental success. The planning objectives for this effort also incorporated the risk reduction of coastal assets and the sustainability of that risk reduction as gauges of success. The coastwide planning objectives, which represent the desired attributes of any plan, are listed below.

By establishing a full and diverse range of values, the plan formulation process ensures development of alternative plans that will be gauged and selected to meet both the State and Federal directives.

Coastwide Planning Objectives

- Reduce storm damage vulnerability of coastal communities, resources, and infrastructure.
- Minimize exposure of traditional flood protection measures to open Gulf conditions.
- Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands, rebuild marsh substrate, and construct flood protection projects.
- Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function, including dissipation of storm energy.
- Establish or maintain dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (fluctuation related to normal daily and seasonal tidal action or exchange).

Planning Unit Specific Needs and Objectives

The implications of future risk based on the existing conditions or "base plan" provide a basis for defining specific geospatial landscape needs which have been expressed as planning unit objectives. These objectives defined the specific needs and impacts within planning units once the assessment of future risks was completed. The planning unit objectives do not define rules for alternative plan development, but more clearly define specific goals that plans will aim to achieve, accepting that it may not be possible to achieve all objectives. The planning unit objectives address both hurricane risk reduction and coastal restoration, and provide discreet and geographically specific representations of the Coastwide Planning Objectives. Tables summarizing this baseline information for each planning unit are located in Enclosure A.

Alternative Plan Formulation Rationales

In the initial iteration of Step 3 of planning, basic rationales for assembling measures into alternative plans were derived from the overall vision compiled from the planning principles and coastwide objectives. The baseline information on assets, issues, and risks, as well as the geographically specific planning unit objectives, facilitated the creation of alternative plans based on these rationales. The formulation rationales represent simplified perspectives for the combination of varied levels of structural, non-structural, and coastal restoration measures that incorporate additional degrees of short- to long-term delivery and sustainability.

The variability in these basic rationales allows the ability to create additional plan combinations of structural, non-structural, or coastal restoration measures. The application of structural risk reduction measures in these rationales is distinguished by the ability to efficiently provide the maximum level of risk reduction or to provide the most efficient level of risk reduction at the specified level. Alternative hurricane risk reduction system alignments have been, and continue to be, considered and modeled to address those levels of efficiency.

Two initial rationales for plan assembly have been developed. Enclosure A provides the details of two alternative plans corresponding to these initial rationales. These plans provide an appropriately broad range of combined measures to begin Step 4, the evaluation of the effects of each alternative and Step 5, comparison of plans. Additional rationales may result as the plan formulation process is executed. More refined alternative plans will certainly result from this iterative formulation process. This planning process will ultimately provide an adequate range of plans, measures, and their application to support effective decision-making, Step 6 of the planning process.

Rationale 1

Rationale 1 provides for maximum structural risk reduction, without constraints by local (asset) benefit/costs. Landscape features will be created and sustained using mechanical means. Long-term O&M costs are not a constraint at this stage of plan formulation.

Specifically, this rationale was applied using the following parameters:

- Maximum hurricane risk reduction for all communities where technically feasible (using judgment at this stage).
- Minimize overall length of flood risk reduction features regardless of primary wetland impacts (with regard to technical feasibility and maximizing efficiency). Projects will be designed to avoid, minimize, or mitigate primary wetland impacts of any alignment.
- Ecosystem restoration projects or combinations maximize acres of wetlands and other coastal features in the near term (e.g. long distance pipeline of material for creation of land). Sustainability will be provided by mechanical methods.

Rationale 2

Rational 2 provides for variable levels of structural risk reduction with non-structural alternatives for risk reduction (e.g. coastal restoration, evacuation planning, raising or relocating assets). Projects will reflect benefit/cost constraints and include self-sustaining environmental options. Long-term O&M costs will be minimized.

Specifically, this rationale was applied using the following parameters:

- Variable hurricane risk reduction for all communities where feasible; level of risk reduction defined by assessment of risk to the human economic assets (based on analyses of concentrated and distributed assets).
- Minimize overall system impacts by minimizing flood risk reduction project disruptions to wetland ecosystems (e.g. minimize acres of wetlands impounded, minimize constrictions to normal hydrologic exchange, maximize non-structural solutions, use natural land forms).
- Ecosystem restoration projects or combinations ensure self-sustaining processes are restored (i.e. large scale diversions to build and sustain wetlands, or combine marsh creation with smaller diversions to sustain wetlands).

Additional Rationale

A third rationale would be a logical iterative formulation of the optimized components of the two initial rationales. The Federal directive is addressed by combining features to achieve effective storm surge reduction and could be expressed as a variation of Rationale 2 by applying the following parameters:

- Variable hurricane risk reduction for all communities where feasible; level of risk reduction defined by assessment of risk to the human economic assets (based on analyses of concentrated and distributed assets).
- Minimize overall system impacts by minimizing flood risk reduction project disruptions to wetland ecosystems (e.g. minimize acres of wetlands impounded, minimize constrictions to normal hydrologic exchange, maximize non-structural solutions, use natural land forms).
- Ecosystem restoration projects maximize risk reduction from storm surge to levees and to unprotected communities/assets and are optimized for long-term sustainability.

The alternative plan resulting from this approach would produce an optimized combination of risk reduction and restoration measures and could potentially represent a nested subset of a broader State plan that meets the directives of Act No. 8.

East Timbalier Island Restoration

Development of Alternatives for the Final Technical Report

An ongoing partnership has been formed between the Corps of Engineers on this effort, and the State of Louisiana in development of their State Master Plan, to conduct this alternative plan formulation process consistent with the decision framework. Enclosure A describes the State/Corps process for plan formulation. In addition, the U.S. Fish and Wildlife Service provided the Corps of Engineers with a Plan Formulation Planning Aid Report, which is attached in Enclosure I. This report provides the Service's plan formulation-related comments and recommendations regarding proposed levee alignments, preferred coastal wetland restoration strategies, and specific restoration measures. The Service's major plan formulation concerns, recommendations, and comments are included in the report as a guide for future LACPR planning and decision-making.

In the process currently being pursued by the Corps and the State (described in Enclosure A), initial alternative plans will be developed for each planning unit. Each initial alternative plan will be formulated through an iterative process of continued formulation that is coupled with technical evaluations. The technical evaluation will assess the projected performance of each alternative in addressing planning unit needs and in achieving coastwide objectives. Alternatives will be evaluated to assess economic, social, and ecological benefits and impacts, as well as construction, operations, and maintenance/repair costs. Specific evaluation criteria will be developed to gauge effectiveness in these areas versus the planning objectives. During plan development, the alternatives will be reformulated and/or refined with the aim of optimizing performance against the objectives. The assessment data for each optimized alternative plan will be presented in the matrices that will be developed for the Final Technical Report.

A suite of technical evaluation tools and methods will be used to evaluate the alternative plans. These tools and methods include multi-dimensional hydrodynamic modeling to identify surge and wave reduction effects, as well as to assess drainage and hydrology requirements; community habitat evaluation modeling procedures to determine individual project component habitat outputs; and ecologic modeling to determine system-wide ecologic/hydrologic benefits and impacts. Cost engineering methodology will be used to estimate dollar values of building and sustaining plan features.

The range of evaluations provided by these tools will be used to help develop the plan and measure component performance. An iterative formulation process will use the quantified modeling and assessment information to identify high performing measures and allow them to be reconfigured with similarly efficient and effective measures. This process may include the identification of high performing measures that were included in one but not all planning units. Then these high performing measures can be reincorporated where appropriate in the overall plans.

The end result will allow decision-makers to readily compare the "pros and cons" of the different alternative plans for each geographical planning unit when determining which measures will be pursued for further development and consideration for construction. The process will also allow opportunities for continued coordination with stakeholders and the general public through the completion of the final report.

Coastal Restoration Measures

The fourth element of the decision framework is to develop information and gain an understanding of the physical landscape relative to any proposed structural features. Just as in the physical environment behind any proposed work, this physical environment in front of works is comprised of various natural, geomorphic, and hydrologic features, such as wetlands, barrier islands, bottom soundings of significance to project design and similar considerations. Such considerations may suggest that some structural measures that might be regarded as main lines of defense should be built further inland than otherwise might seem obvious at first. Conversely, proposed structural features also have an effect on the physical environment around them. These effects are related to geomorphologic and hydrologic function and trends and may extend some distance from the actual feature location.

This concept of the geomorphology related to proposed works in each of the geographical planning units is further illustrated in the Multiple Lines of Defense Strategy described in the next section.

Preliminary alternative plans span the entire coast and describe the coastal restoration measures by planning unit. These alternatives include the following major categories of coastal restoration measures:

- Direct placement of dredged material to achieve creation or restoration of marshes, ridges, and shorelines
- Diversions to create new and sustain existing marshes, and support long-term landscape sustainability

- Management of existing hydrology to promote or maximize wetland sustainability
- Risk reduction through hardening or armoring of shorelines or wetland fringes to eliminate immediate loss and create sustainability

The projects recommended in the LCA Ecosystem Restoration Plan, as a basis for near-term action, also fall into these basic categories. These LCA recommended projects are included in all alternatives being considered in this effort. The following sections describe the coastal restoration measures contained in two preliminary alternative plans, which will be discussed further in Part 7 of this report.

Coastal Restoration Measures in Alternative Plan 1

In Planning Units 1 & 2 for Alternative Plan 1, restoration measures focus heavily on the direct use of sediment available from the Mississippi River, as well as some offshore sources, for wetland creation and ridge and barrier island restoration. In Planning Units 3a & 3b the measures focus heavily on the direct use of sediment from the Atchafalaya River and offshore sources for wetland creation and barrier island restoration. The management of existing hydrology is also a major focus in these units. Non-structural measures are also identified for specific locations in Planning Unit 3a. In Planning Unit 4 the principal coastal restoration measure focuses on the management of hydrology. Use of sediment is also identified in Planning Unit 4 but limited to material available from maintenance of existing navigation projects. The restoration or risk reduction of some critical shorelines is also identified in all these units.

Coastal Restoration Measures in Alternative Plan 2

In Planning Unit 1 for Alternative Plan 2, the direct use of Mississippi River and other sediment sources is expanded. In Planning Unit 2 the use of sediment is expanded to include the restoration of numerous natural ridges and interior barrier features. In addition, multiple introductions of Mississippi River freshwater and sediment, and barrier restoration, are included in both units. In Planning Units 3a & 3b this alternative expands upon the measures in Alternative Plan 1 by incorporating extensive interior barrier and shoreline risk reduction features. In Planning Unit 4 a significant change in the long-term approach to sustainability is identified by allowing Calcasieu Lake and the surrounding area to become and remain brackish to saline. Measures to protect critical Gulf shorelines and use available sediments for channel maintenance are retained and additional measures incorporate sediments from offshore sources. The goal is to allow for the transition to a long-term sustainable hydrologic system.

Dustpan Dredge Marsh Creation Demonstration in the Mississippi River Delta

Structural Measures

The fifth element of the decision framework consists of structural risk reduction measures, such as levees, floodwalls, and floodgates. During the preliminary technical investigation alternative levee alignments were developed in conjunction with other Federal, State and local representatives. These alignments do not preclude the discovery and design of alternative alignments that would improve the overall effectiveness of the alternatives.

Confirmation of or amendments to a final structural alignment will be made with consideration of many significant factors, including the effectiveness and efficiency of risk reduction, environmental compatibility, constructability, economic and cultural implications, and other general and local issues. Innovative engineering will also be a key component in the alternative alignment analysis. It is important to note that coordination with local stakeholders has identified some issues with certain alignments. These issues are especially evident in the East Orleans landbridge and lower coastal communities in Lafouche and Terrebonne Parishes. The LACPR team will continue to work with stakeholders to identify alignment alternatives and preferences so as to further inform decision-makers.

Model Alignments

The 11 proposed structural alignments identified at the Plan Formulation Workshop were distilled into five separate modeling alignments for the purpose of storm surge analyses using the initial screening storm, the Probable Maximum Hurricane (PMH). Additional permutations of the proposed alignments would not identify any alignments that would significantly modify the modeled effects on storm surge levels. Thus, sufficient modeling using the five model alignments has already been completed to reasonably estimate how nearly any structural line of risk reduction alignment would influence the localized surge heights (under the PMH scenario). These surge height levels are used to determine the design top elevations of the line of risk reduction features such as levees, floodwalls, and storm gate control structures. The following sections describe each of the five model alignments. The alignment maps show which parishes would leave some residents unprotected. Population numbers are presented in accompanying tables.

Model Alignment 1

Alignment 1 places a barrier levee across Lake Pontchartrain along Highway 90 and along the southwest edge of Lake Borgne. This portion of the alignment includes major structures at the Rigolets, Chef Mentaur Pass, Gulf Intracoastal Waterway (GIWW) and MRGO. This alignment generally follows the existing MRGO, Lower St. Bernard and New Orleans to Venice levee project alignments. Alignment 1 extends as far south as Point a la Hache in Plaquemines Parish. On the west bank of the Mississippi River the alignment extends northward from Point a la Hache and follows a proposed Donaldsonville to the Gulf of Mexico risk reduction alignment along the GIWW. The alignment ties into, and follows, the existing Larose to Golden Meadow risk reduction alignment. Alignment 1 continues from the western side of the Larose to Golden Meadow system near Larose along the proposed Morganza to the Gulf of Mexico risk reduction alignment tying into the East Atchafalaya Basin risk reduction system at Morgan City. From the west side of the Atchafalaya River at Morgan City the alignment runs along the GIWW through the western area of the State to the Sabine River and extends northward tying to the appropriate natural ground elevation. This portion of Alignment 1 would leave the Atchafalaya River and Wax Lake Outlet unimpeded with a ring levee around the Berwick - Patterson area. A major structure on the Calcasieu River would also be included.

Model Alignment 2

Alignment 2 is identical to Alignment 1 with the exception that the major tidal passes into Lake Pontchartrain would not be closed with structures.

Model Alignment 3

Alignment 3 is also identical to Alignment 1 with the exception that the interior of the Barataria Basin from the current extent of the West Bank and Vicinity risk reduction system to the Bayou Lafourche ridge is left open. Highly developed areas are protected by levees extending up the wetland interface on both sides of the Barataria Basin northward from the West Bank system and the Larose to Golden Meadow system. This alignment would require major structures on the GIWW on both sides of the Barataria Basin.

Model Alignment 4

Alignment 4 is based on Alignment 1 with the exception that the alignment crosses the Barataria Basin by following Highway 90. The alignment would follow the northward components of Alignment 3 in the Barataria Basin until they intercept Highway 90 (Planning Unit 2). The alignment would close off the upper extent of the Barataria Basin along this highway. A structure at Bayou des Allemands would be necessary with this alignment.

Model Alignment 5

Alignment 5 is also based on Alignment 1 with several major modifications. First, Alignment 5 cuts diagonally through St. Bernard Parish from the MRGO between Bayou Bienville and Bayou Dupree to point near the southern end of Highway 46. The southern extent of the alignment also ends near the town of Bertandville on the east bank of Plaquemines Parish (all in Planning Unit 1). To the west of the Mississippi River (Planning Unit 2) the alignment crosses Plaquemines Parish from Point a la Hache to Jesuit Bend and then follows Alignment 1 to the Bayou Lafourche ridge. Here Alignment 5 cuts across the Larose to Golden Meadow system (Planning Units 2 & 3a) and follows the GIWW with a southerly dip to encompass the Houma area excluding the southern extent of the Morganza to the Gulf area (Planning Unit 3a).

In the western or Chenier Plain portion of the State (Planning Unit 4) all five alignments follow the 10-foot ground contour with the eastern extent breaking off from the GIWW alignment to protect communities adjacent to Highway 90 until reaching the 10-foot contour near Lafayette. The engineering design team considers of the five model alignments adequate to provide information for all planning units to address the basic design or future consideration of ring levee risk reduction systems.

Model Alignment 1 & 2: Unprotected Populations by Parish

Model Alignment 3: Unprotected Populations by Parish

Model Alignment 4: Unprotected Populations by Parish

Model Alignment 5: Unprotected Populations by Parish

The figures presented here and the supporting analysis provides only preliminary results for comparative measure of risk reduction for each modeled alignment. The populations, protected and unprotected, were derived from a direct spatial correlation of the model alignments and census tract data from the 2000 U.S. Census. For the Final Technical Report, a more data intensive analysis will be performed to define protected/unprotected populations per modeled alignment. An analysis of this nature will likely require evaluation of current populations in relation to inundation risks from model scenarios and alternative levels of risk reduction.

Unprotected Population By Alignment				
Parish	1 & 2	3	4	5
Acadia	0	0	0	0
Ascension	0	0	0	0
Assumption	15	322	15	15
Calcasieu	426	426	426	426
Cameron	6,793	6,793	6,793	6,793
Iberia	0	0	0	0
Iberville	0	0	0	0
Jefferson	4,454	7,336	7,336	4,454
Jefferson Davis	0	0	0	0
Lafayette	0	0	0	0
Lafourche	162	6,784	516	22,164
Livingston	0	0	0	0
Orleans	194	194	194	194
Plaquemines	11,128	11,128	11,128	15,688
St. Bernard	1,215	1,215	1,215	8,558
St. Charles	0	1,181	695	0
St. James	0	0	0	0
St. John the Baptist	0	269	0	0
St. Martin	0	0	0	0
St. Mary	915	915	915	915
St. Tammany	1,619	1,619	1,619	1,619
Tangipahoa	0	0	0	0
Terrebonne	2,446	2,446	2,446	20,358
Vermilion	726	726	726	726
Total	30,093	41,354	34,024	81,910

Percent Protected By Alignment				
Parish	1 & 2	3	4	5
Acadia	100.0	100.0	100.0	100.0
Ascension	100.0	100.0	100.0	100.0
Assumption	99.9	98.6	99.9	99.9
Calcasieu	99.8	99.8	99.8	99.8
Cameron	26.3	26.3	26.3	26.3
Iberia	100.0	100.0	100.0	100.0
Iberville	100.0	100.0	100.0	100.0
Jefferson	99.0	98.4	98.4	99.0
Jefferson Davis	100.0	100.0	100.0	100.0
Lafayette	100.0	100.0	100.0	100.0
Lafourche	99.8	92.5	99.4	75.4
Livingston	100.0	100.0	100.0	100.0
Orleans	100.0	100.0	100.0	100.0
Plaquemines	58.4	58.4	58.4	41.4
St. Bernard	98.2	98.2	98.2	87.3
St. Charles	100.0	97.5	98.6	100.0
St. James	100.0	100.0	100.0	100.0
St. John the Baptist	100.0	99.4	100.0	100.0
St. Martin	100.0	100.0	100.0	100.0
St. Mary	98.3	98.3	98.3	98.3
St. Tammany	99.1	99.1	99.1	99.1
Tangipahoa	100.0	100.0	100.0	100.0
Terrebonne	97.7	97.7	97.7	80.5
Vermilion	98.7	98.7	98.7	98.7

Protected Population By Alignment				
Parish	1 & 2	3	4	5
Acadia	58,853	58,853	58,853	58,853
Ascension	76,627	76,627	76,627	76,627
Assumption	23,373	23,066	23,373	23,373
Calcasieu	183,151	183,151	183,151	183,151
Cameron	2,429	2,429	2,429	2,429
Iberia	73,266	73,266	73,266	73,266
Iberville	33,230	33,230	33,230	33,230
Jefferson	449,542	446,660	446,660	449,542
Jefferson Davis	31,435	31,435	31,435	31,435
Lafayette	190,503	190,503	190,503	190,503
Lafourche	89,760	83,138	89,406	67,758
Livingston	91,814	91,814	91,814	91,814
Orleans	484,355	484,355	484,355	484,355
Plaquemines	15,629	15,629	15,629	11,069
St. Bernard	66,014	66,014	66,014	58,671
St. Charles	48,072	46,891	47,377	48,072
St. James	21,216	21,216	21,216	21,216
St. John the Baptist	43,044	42,775	43,044	43,044
St. Martin	48,583	48,583	48,583	48,583
St. Mary	52,422	52,422	52,422	52,422
St. Tammany	179,433	179,433	179,433	179,433
Tangipahoa	100,588	100,588	100,588	100,588
Terrebonne	102,057	102,057	102,057	84,145
Vermilion	53,081	53,081	53,081	53,081
Total	2,518,567	2,507,306	2,514,636	2,466,750

Ring Levees

Ring levees are levees that completely encircle or "ring" an area subject to inundation from all directions. Ring levees are a viable alternative for less densely populated areas or remote industrial facilities that are outside the limits of a continuous hurricane risk reduction alignment. This approach offers an opportunity to lower costs and construction periods as compared to lengthy border to border or other more continuous alignments.

Non-Structural Measures

The sixth element of the new decision framework is to develop information as to the most appropriate non-structural measures for hurricane risk reduction in each of the geographic planning units. The LACPR final report, and such interim reports as may prove helpful, will identify and describe such non-structural measures and their relative significance for that unit and for the system as a whole. Non-structural measures are likely to include the following:

- Evacuation plans.
- Inundation maps that display gradations of flooding that could be expected to occur in each

of the geographic planning units under each scaled alternatives for structural measures in each respective storm.
- Flood plain and zoning management plans.
- Other, such as local building codes.

Within the context of a comprehensive system of levees and coastal ecosystem restoration measures that may comprise the LACPR project, the opportunity exists to incorporate a wide range of non-structural measures on a larger scale than ever before executed in a Corps of Engineers project. Although non-structural measures alone cannot provide total property protection from flood stages associated with every storm event, these measures can effectively supplement the hurricane risk reduction system and allow for greater project design flexibility.

The vast scale of any comprehensive system of coastal ecosystem restoration and levee construction will take many years to complete. Non-structural measures can be implemented more rapidly and provide a degree of interim risk reduction within and outside of the existing hurricane risk reduction system. The hurricane risk reduction afforded by non-structural features is considered an integral component of the overall engineering solution. The most important non-structural measures, however, are those that protect lives.

Education/Evacuation

Educating the public about the dangers of hurricanes, levels of risk reduction that exist across the coast, and the need to prepare personal hurricane response plans can provide a level of safety in terms of public awareness. The more information the public has about storms and associated risk, the more prepared individuals are likely to become. An important component of public education is developing awareness of evacuation plans. Evacuating communities during hurricane threats is the most important step that can be taken to save lives. Public officials have a responsibility to develop well-managed evacuation plans and to educate the public regarding the implementation and execution of these plans. These efforts should include public service announcements, signage, literature and map distribution, and practice sessions.

Flood Proofing

Flood proofing provides some level of risk reduction for structures and contents. Dry flood proofing involves sealing the walls of structures with waterproofing compounds, impermeable sheeting, or other materials along with closures for protecting openings from floodwaters. Wet flood proofing allows the structure to flood inside while ensuring there is minimal damage to a building. For example, first floor portions of multilevel buildings such as hospitals, office buildings, or hotels can be used for non-critical functions. Vulnerable items are relocated or temporarily waterproofed with plastic bags and sheeting. This is an option if dry flood proofing is impossible or too costly.

Elevation

Elevating buildings is a non-structural alternative that is currently being considered by some residents. However, without new municipal ordinances mandating the elevation of dwellings and other structures, decisions to pursue structure raising will be made by property owners and will invariably be influenced by subjective evaluations of relative benefits and costs.

For structures that will be rebuilt, using current, existing building codes and floodplain management requirements, those structures will be constructed at or above the post-Katrina base flood elevation (BFE) for that area. This is a significant consideration in planning for reconstruction since most of the affected structures were built before flood insurance rate maps were published and were considerably below the BFE. Sixty percent of residences covered by national flood insurance in the New Orleans area are below the BFE. The elevation difference between the BFE and the stage associated with a particular design storm must be demonstrated on a case-by-case basis to determine the scale of design modifications necessary to elevate structures above that design storm elevation.

Relocation

An effective program of buy-outs is usually confined to circumstances in which the complete removal of all structures from an area under study has a high probability of success. Although the identification of some candidate buy-out areas in coastal Louisiana is not expected to be difficult, coordination with regional planners and community representatives will be required to support specific recommendations. The most expedient buy-outs will be those parcels where structures have been damaged or destroyed and not yet rebuilt. The likelihood of buy-outs in an area that suffered damages is higher if the area is targeted for alternative use as part of any future land use master plan.

Prime Point: Strong Houses Resist Strong Storms

Amidst the damage and destruction of Hurricanes Katrina and Rita a few examples of residential construction success dot the tattered Louisiana landscape. Aerial surveys and inspections have documented a number of houses that survived the storms with relatively minor damages. Several of these houses were located directly in the path of Hurricane Katrina's high winds and storm surge.

In Myrtle Grove, Louisiana, several recently constructed houses successfully withstood the winds of Hurricane Katrina. Located just 32 miles from where the eye of the storm made landfall in Buras, the houses withstood sustained 80 mile per hour winds and gusts of up to 100 miles per hour. Yet damage to these homes was limited to the loss of some metal roofing panels and a few pieces of vinyl siding.

The surviving houses in Myrtle Grove used proven wind-resistant design and construction techniques. For example, shutters were designed to protect against significant impact, hurricane straps were used at critical connections throughout the wood framing, and the connections between the houses and their foundations were strong. Not only are these construction methods highly successful, they are also, for the most part, relatively inexpensive.

In Shell Beach, Louisiana several houses in a new fishing camp development known as Ft. Beauregard Marina Estates also withstood the storm's winds and high surges. Another example of successful residential construction can be found in the Lake Catherine community on the East Orleans land bridge where some of the elevated homes survived the storm whereas all of the ground-level and most of the lower-elevated structures in the area were destroyed.

In all of these cases, damage to the homes was limited to impacts from strong winds and not flood waters from storm surge. Engineers, developers, community planners and insurers have taken note of these residential construction successes and are working to apply the lessons learned to community reconstruction efforts. Following the 2005 hurricane season, the State of Louisiana passed new building code legislation increasing construction requirements to increase storm resistance.

The first key to the success of these structural survivors is elevation. Homes that stood above the level of flooding and surge avoided water damages and did not float off their foundations or piers. Other key design and construction factors include providing openings or breakaway wall components in ground level construction, placing mechanical and electrical building support systems above flood elevation, and thorough quality control during construction to ensure proper installation of all components.

The LACPR project development team believes that application of non-structural residential construction techniques may offer the most reasonable approach for protecting areas with low-density populations. In all cases these non-structural measures should be a prominent component of hurricane risk reduction plans because they offer the most affordable and reliable system of hazard mitigation. In addition, given the lengthy construction timeframes associated with developing a "Category 5" levee system, the fastest option to increase hurricane risk reduction for South Louisiana residents may be to build higher and stronger structures during initial community reconstruction periods.

Shell Beach, Louisiana Post-Hurricane Katrina

View of Both Destroyed Homes and Some Structures that Survived Hurricane Katrina in Shell Beach, Louisiana.

Prime Point: Coastal Features and Storm Surge

There is growing consensus among scientists involved with Louisiana hurricane risk reduction and coastal restoration that future hurricane risk reduction projects for New Orleans and the Louisiana coast must include plans to sustain or enhance the wetland-dominated landscapes that surround the area. Although these landscapes are widely recognized for their great value to the Nation for the natural resources and ecosystem services they provide, these wetlands also function to provide some level of risk reduction from hurricane wave action and storm surge.

Coastal geologic features and associated vegetation, manifested in the presence of barrier islands, cheniers, maritime forest ridges, river tributary ridges, and wetlands, have the potential to abate and restrict flow exchange between the estuarine and sea environments. Compared to deeper open water, these shallower coastal areas have increased drag, which slow water velocities and may reduce the effects of propagating storm surges and waves. Together, the elevation and vegetation of coastal features have potential to restrict the volume of water at areas landward of barriers.

Despite the qualitative knowledge of the potential effects of landscape features on hurricane risk reduction, there have been few studies that have quantified these effects in nature. In an initial literature review, several studies investigated the effects of natural features on reducing storm surge elevations. In a Letter from the Chief of Engineers (1965) documenting an interim hurricane survey of Morgan City and vicinity, Louisiana, measurements of high water marks due to hurricane surge were correlated with distance inland from the coast. The report described the area as containing numerous bays and marshes. A trend was observed for the decrease in storm surge as a function of distance inland, and was independent of hurricane forward speed, wind speed, and direction. This trend indicates that storm surge was reduced by 1 foot for every 2.75 miles inland. In 2004, the Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority suggested that storm surge is reduced about 3 inches (0.25 feet) per mile of marsh along the central Louisiana coast.

Subsequent to the 2005 hurricane season, The Working Group for Post-Hurricane Planning for Louisiana Coast wrote "barrier islands, shoals, marshes, forested wetlands and other features of the coastal landscape can provide a significant and potentially sustainable buffer from wind wave action and storm surge generated by tropical storms and hurricanes." ADCIRC results have indicated that replacing wetlands east of the MRGO with 8 feet of open water would have increased storm surge elevations from Hurricane Katrina by 3 to 6 feet for St. Bernard Parish and East New Orleans.

The role of wetlands and other coastal features in reducing storm surges and waves must be addressed. A quantitative evaluation of the role of wetlands and other coastal features in reducing storm surge and waves in coastal Louisiana is needed. The literature review will be continued and a set of idealized numerical modeling tests will be conducted to evaluate the reduction in surge as a function of landscape feature and vegetation type. This modeling will include comparisons of the 1956, current, and projected 2050 coastal features of Louisiana recreated in an ADCIRC model. These modeling results will be presented in the Final Technical Report.

Chandeleur Island Shoreline

Chandeleur Island shoreline (2001) prior to erosion and damage from hurricanes and tropical storms. Barrier islands absorb high energy waves in advance of hurricanes and other tropical storms.

Prime Point: The Hurricane Threat to New Orleans

The greater New Orleans area flanks the east and west banks of the Mississippi River and is surrounded by a series of large estuarine bays and lakes. Although the city is about 100 river miles inland from the Gulf of Mexico, its location along the shores of these bays and lakes and the rapid loss of coastal wetlands now places the city very close to the open sea. Combined with low-lying topography, in some cases below sea level, the city and surrounding communities face significant flooding risks from rainfall, spring river runoff, and hurricane storm surges. From early in its history the city has relied upon a system of canals, levees and pumps to combat these flooding threats. A significant local and Federal investment in these levee and drainage systems helps to support and protect residents that work in the area's vital port, energy production, seafood, medical and military manufacturing economic sectors. Each of these business areas produces important goods and services for the region and Nation in turn helping support the unique cultural heritage of the city known for the birth of jazz, vibrant arts, and famous cuisines.

As hurricanes approach the New Orleans area, counter clockwise winds from the south and southeast push water from the Gulf of Mexico into Breton Sound, Lake Borgne, and through large tidal channels into

Lake Pontchartrain. This water accumulates in the surrounding water bodies and rises against area levee systems and along the lower reaches of the Mississippi River delta in advance of storms. During a hurricane landfall, storms push and carry ocean surges and waves across the surrounding wetlands and into the bays and lakes. In some cases, powerful coastal storms also push surges up the Mississippi River many miles above New Orleans. This scenario leaves greater New Orleans an island surrounded by storm surge and dependent upon levee systems to prevent inundation.

The hurricane storm surge threat to communities in the Lake Pontchartrain basin is well established. In July 2005, about 1.4 million people lived in the immediate vicinity of the Lake Pontchartrain Basin, including Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist, St. Tammany, and Tangipahoa Parishes. Residents of the Lake Pontchartrain Basin face significant storm surge risks each year. Many years of coastal erosion coupled with Hurricane Katrina's damages to the estuaries surrounding New Orleans have reduced the natural storm defenses around the city by more than 500 square miles. When coastal wetlands erode they turn into shallow open water reducing storm surge and flood buffering and further increasing the volume of water that surrounds the city. As witnessed during Hurricane Katrina, storm damages to Louisiana result in economic and social disruptions that impact not just the Gulf coast region but the Nation as a whole. The direct physical losses from Hurricane Katrina have been estimated to exceed $90 billion and reverberations have been felt in the energy, agriculture, trade, transportation, seafood, and insurance sectors nationwide.

To combat the threat of storm surges in the New Orleans area the Federal government has designed and built a series of levees and flood walls to prevent hurricane related flooding. More than 350 miles of levees now surround the city as a primary structural line of defense against storm threats. In the late 1960s the Corps of Engineers developed a plan that would construct barrier gates across the Lake Pontchartrain tidal passes to prevent storm surge from entering the lake. For a number of reasons that component of the levee risk reduction system was never constructed. The current levee system is a result of a complex series of decisions regarding locations, designs, environmental impacts, and levels of risk reduction governed by local agreements, court cases, and Congressional authorizations and appropriations. The levee systems in place to protect this population are known to be inadequate because they were not designed to defend against nature's strongest hurricanes. A primary conclusion of the IPET team and other post-Katrina evaluations has revealed that the area's hurricane risk reduction structures do not function as an integrated system as intended or needed. As a result, the greater New Orleans area continues to face significant risks from powerful Gulf hurricanes.

Flooded Homes in New Orleans After Hurricane Katrina

Prime Point: The Dutch Approach

From almost the first day of the tragedy of Hurricane Katrina, the U.S. hurricane risk reduction system has been compared with the storm and flood risk reduction efforts of The Netherlands. To many, the so-called "Dutch Approach" has been held as the gold standard for storm risk reduction.

The history of The Netherlands is the story of a society learning to live in a flood-prone area. Following the disastrous 1953 flood, the Dutch adopted the mantra, "Never again," and undertook an aggressive and thorough plan to protect their citizens from flooding.

Today, 60% of the Dutch population is protected by storm surge barriers and levees. This area also accounts for more than 60% of the nation's Gross Domestic Product. Amsterdam and other major cities at or below sea level are protected by a cohesive coastal management and flood risk reduction policy based on rational standards and an unwavering financial, engineering, and social commitment. Critical areas of The Netherlands are provided with extremely high levels of risk reduction.

There is nothing technologically unique or exceptional about the barrier system protecting The Netherlands. What makes the "Dutch Approach" successful is the absolute national support of the flood risk reduction program. The Dutch began with an unambiguous commitment to solving their flooding problem. They made bold decisions, and then properly funded the solutions. With a similar commitment, boldness, and funding the U.S. can implement a similar level of hurricane risk reduction for coastal Louisiana.

It should be noted that conditions in coastal Louisiana are not the same as in The Netherlands and thus the resulting risk reduction system will necessarily be different. The very survival of their nation, has moved the Dutch to implement a multi-decade, multi-billion dollar solution with support of their government backed in laws and budgets. Members of the LACPR team have worked closely with engineers, scientists, and managers from The Netherlands. The exchange of technical information and provision of critical advice has been very helpful and is greatly appreciated. The LACPR team envisions furthering these cooperative assistance efforts as more detailed LACPR plans are developed.

Tidal Defenses at the Eastern Scheldt

Tidal Defenses at the Eastern Scheldt (Aerial View)

The Maeslant Barrier

Prime Point: Coastal Engineering Design Challenges

Engineering in the coastal environment of South Louisiana presents several short-term and long-term design challenges. South Louisiana generally has inherently poor soil foundation conditions for building, which makes construction of higher levees a design challenge. There is also the issue of identifying and transporting the large volumes of soil borrow materials needed to increase levee heights. Long–term challenges include coastal subsidence, wetland impacts, faulting, and relative sea level rise. Structures installed must be planned, designed, and constructed to protect assets from storm surge and waves over the entire project life span. Additional information about these engineering design challenges is presented in Enclosure F.

Poor Soil Foundation Conditions

Foundation settlement is a key component of the estimated levee construction cost. Consolidation and lateral spread of soft clays in foundation soils produce substantial settlement of constructed barriers. In the eastern region of coastal Louisiana, the deltaic plain foundation soils are composed primarily of soft peat and clay deposits. The settlement analysis of a 30-foot high earthen levee constructed on unimproved foundation soils predicts as much as 20 feet of total settlement. This massive settlement makes construction of the levee untenable. However, by using deep soil mixing and soil-cement technologies, long-term settlement can be reduced to about 8 feet over the life of the project. Other innovative technologies may also be used to further reduce settlement and improve project success.

In the western region of coastal Louisiana, the chenier plain foundation soils are composed of coarse- to fine-grained sediments which often form ridges parallel to the coast. The settlement analysis of a 30-foot high earthen levee constructed on these western Louisiana unimproved foundation soils predicts less than 8 feet of settlement without using innovative technologies such as deep soil mixing.

Large Volumes of Borrow Materials

Large volumes of clay, silt, and sand will be required for the construction of higher levees. Because the proposed project extends across the entire Louisiana coast, numerous borrow sources will be required. Potential silt and sand sources include the Mississippi, Atchafalaya, and Vermilion Rivers, as well as tidal deltas and offshore shoals in the Gulf of Mexico. Sources of silt and clay include natural levee deposits of past and present Mississippi River courses and Pleistocene terrace deposits.

Given the need for large quantities of sediment for coastal restoration and levee construction, an emphasis should be placed on instituting Regional Sediment Management plans as part of LACPR efforts. Managing sediment to benefit a region potentially saves money, allows use of natural processes to solve engineering problems, and improves the environment.

Impacts on Wetlands

Protecting coastal Louisiana will likely involve construction in and near wetlands. When a fixed barrier, such as a floodwall or levee is placed in wetlands, there are several kinds of impacts. One impact is the physical replacement of acres of wetlands with the barrier and, in some cases, borrow canals. For levees built to withstand hurricanes comparable to a Category 5 storm, this impact can be in the range of over 100 acres of wetland loss per mile of levee built. When adjacent borrow is used for levee construction, wetland loss can be increased by a factor of two or more. In addition to this direct impact, levees compartmentalize the wetlands and disrupt the natural hydrology. Disruptions of natural hydrology can impact wetland functions, and when water is impounded on wetlands, the resulting water logging can kill wetland plants and lead to wetland loss. Placement of structures that can be left open on a daily basis to allow for tidal movement reduces some of the hydrologic disruption, but any sheet flow across wetlands is generally interrupted by levees. The LACPR team is working with State and Federal natural resource agencies to minimize impacts and identify plans that complement coastal restoration efforts.

Relative Subsidence

The entire Louisiana coast is experiencing relative subsidence. Relative subsidence is defined here as the net effect of numerous factors that result in the downward displacement of the land surface relative to sea level. These factors include worldwide sea level rise, geosynclinal downwarping, compaction of Holocene deposits, and faulting. Recent studies have shown that subsurface fluid withdrawal and drainage for agriculture, flood risk reduction, and development may also be major contributors to relative subsidence and resulting wetland loss.

Relative subsidence rates vary considerably across coastal Louisiana. In general, natural rates of relative subsidence are highest near the coast and at the mouth of the Mississippi River where young thick sediments are present. Currently, no coastwide system has been established for quantifying and predicting relative subsidence on a regional scale.

Geological Faults

Recent investigations have identified likely areas of fault-induced subsidence but the magnitude and spatial extent of their impact is still being investigated. The Baton Rouge fault is probably the best known example of an active fault that has caused some structural damage. This east-west fault crosses the proposed alignment approximately 6 miles south of Slidell. Most fault planes in coastal Louisiana generally trend east-west and may contribute to increased maintenance at the location where they intersect the proposed project. A minor amount of movement along fault planes can have significant impacts on wetlands where marsh accretion barely exceeds relative subsidence.

Sea Level Rise

Variations and trends in the relationship among local mean sea level, worldwide mean sea level, and land elevations are important considerations in the planning and design of coastal structures. The relative local mean sea level for the Louisiana Coast has increased by rates up to 9.9 mm/year (or 3.2 feet/century). Although the rate of eustatic mean sea level rise does have an effect on the rate of relative local mean sea level change, it often is not the most important factor. Other factors that can effect relative local mean sea level change include crustal subsidence or uplift; tectonic activity; human-induced subsidence from structural loading or groundwater, oil, or natural gas extraction; auto-subsidence from consolidation of native sediments; and climatic fluctuations such as El Nino Southern Oscillation. Hurricanes considered minor by current standards could have major consequences in Louisiana as sea levels rise producing intensified tidal surges, erosion, flooding, and saltwater intrusion. Engineering Regulation 1105-2-100 recommends a range of sea-level rise rates for consideration in the planning and design of coastal structures and wetlands. These rates and the methods by which they will be addressed in the planning and design of coastal wetland and features are specified in Enclosure F.

Damaged Floodgate and Levee at Bayou Dupre, Louisiana

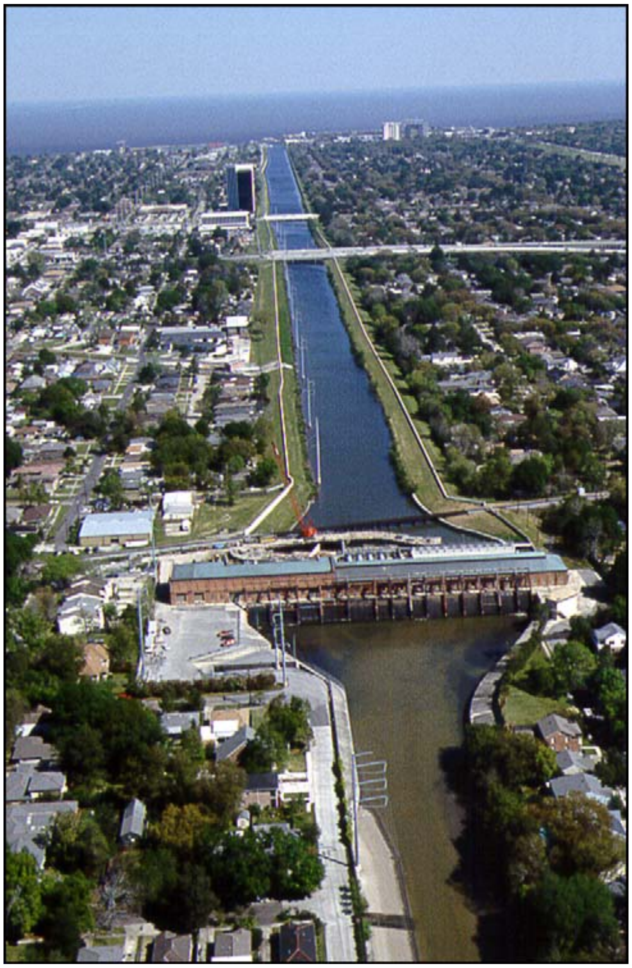
Interior Drainage Modeling

The location and size of the levees for any of the five proposed model levee alignments present considerable challenges for drainage designers. Where existing levees are being considered for increased levels of risk reduction, existing drainage facilities such as pumping stations, culverts, and water control structures will need to be modified or replaced to accommodate the expected increase in the heights of the proposed levees and increased widths necessary for levee stability. Another drainage design issue is the need to pump during a "Category 5" storm surge. Water levels and expected differential heads (using even the newest pumping stations) will severely reduce pumping capacities, thus making the protected areas vulnerable to flooding from rainfall.

For the preliminary report, the interior drainage design team inventoried all available numeric hydrodynamic models that have been developed for South Louisiana. The interior drainage team has also developed a list of all pumping stations, drainage structures, and navigation structures that are located in South Louisiana and that will be affected by any of the proposed levee alignments. Most of the proposed alignments provide a continuous protective barrier across the entire State of Louisiana and, with the exception of large rivers where the line of risk reduction crosses existing bayous, canals, and navigation channels, it will be necessary to provide structures that can be closed when a hurricane approaches.

For preliminary design purposes, these structures were established using the types and sizes of structures proposed in Morganza to the Gulf project. The Morganza to the Gulf project provides a template for the rest of the State except in cases where large tidal passes require much larger structures (i.e. the Chef and Rigolets between Lake Borgne and Lake Pontchartrain and in Barataria Basin where the proposed Gulf Intracoastal Waterway alignment crosses the bayou connecting Lake Salvador to Bayous Perot and Rigolettes). For these locations, these structure sizes were conservatively estimated so that their open area closely approximates the existing cross section available for flow. A summary of these drainage structures are included in Enclosure F. The Final Technical Report will provide additional information regarding the capacity of primary, secondary, and tertiary drainage systems to handle flows produced by a new levee system.

Pump Station #6 on the 17th Street Canal in New Orleans



Identifying a Plan of Action

The intent of the initial LACPR effort is to identify a framework by which to inform options for enhancing hurricane risk reduction and risk reduction measures. A number of factors should be considered in developing plans to reduce the hurricane risks that challenge the risk reduction of coastal communities in Louisiana. The LACPR technical team and vertical team have identified some critical evaluation criteria for initial plan development and identification. The screening factors listed below have been applied in formulating and specifying potential plan components for the initial LACPR report:

- Narrow solution set.
- Extensive study not likely to significantly change problem-solving approaches.
- Component area of a comprehensive system.
- Significant populations and assets at risk.
- Independently functioning component for coastal risk reduction and restoration.
- Avoids multi-billion dollar cost consequences associated with storm risks.

In some cases consideration of these factors may lead to the development of comprehensive structural risk reduction measures for communities or in other cases decision-makers may identify a suite of best practices that would better serve residents in terms of speed of implementation and lower required government capital investments. The LACPR team will collect and analyze additional engineering, meteorological, economic, social and environmental data (primarily from existing sources) and present the information to the public and decision-makers to assist in selecting future plans for reducing hurricane surge damage risks to Louisiana's coastal populations. These initial criteria are not the only factors that will be considered in plan development but were applied at this stage for an initial screening of options and plan measures. A full range of information will be developed and presented in a decision support framework that allows for selecting individual components and/or incorporation of these items into a larger plan for South Louisiana. Additional components for protecting and restoring other areas in southern Louisiana will continue to be considered and developed in detail for the Final Technical Report.

Destroyed Floodwall Along the Inner Harbor Navigation Canal

Photo showing floodwaters receding from the lower 9th Ward two days after Hurricane Katrina. Storm surge entered this New Orleans neighborhood when it overtopped the floodwall leading to collapse of a section of the structure.

Integration of Risk Reduction Measures

The seventh element of the decision framework is the integration of risk reduction measures. This involves any existing navigation, flood prevention, hurricane risk reduction or environmental restoration works, projects or plans that are relevant to increased levels of storm risk reduction. The LACPR study will assume that the New Orleans Hurricane Risk Reduction System as authorized and appropriated for in the 4th Supplemental Appropriations measure will be in place. Further, the Final Technical Report will assure that full consideration is given to coordination and integration with the Mississippi Coastal hurricane risk reduction study now being planned.

This framework will result in an information matrix that will display three distinct but fully integrated layers of risk reduction measures of scaled alternatives for each geographical planning unit, and together can result in recommendations for a combined or comprehensive system for risk reduction measures for South Louisiana. These three layers are as follows:

- Wetlands, Barrier Islands and bottom characteristics on the seaward edge of the geographical planning units.
- Structural alternatives to provide risk reduction for respective storms and storm tracks.
- Non-structural measures most appropriate for each geographical planning unit.

Each of these layers of information will be in a matrix that is further informed by the assets to protect in each geographical planning unit and an assessment as to the practicality for each of the respective scaled alternatives to be integrated with one another into a three-layered Risk Reduction System.

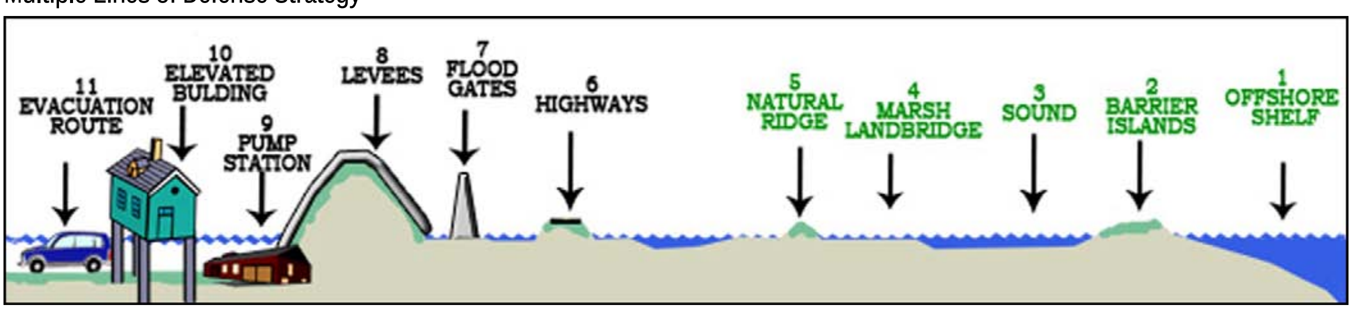
Hurricane Risk Reduction Strategies

Measures and strategies for providing coastal risk reduction are presented here in broad form by major category. There are many possible alternative combinations of these measures and strategies that the plan formulation will ultimately develop. Enclosure A provides comparative tables of all currently identified potential measures for each geographical planning unit.

Each of the three major categories of coastal risk reduction measures – structural (e.g. levees and floodgates), non-structural (e.g. elevated buildings and evacuation routes), and coastal restoration (e.g. barrier islands, marshes, and ridges) – represents a strategy for providing risk reduction. The sole use of any one of these groups of measures would produce a varied level of success and be accompanied by specific risks and impacts. The application of homogenous sets of measures requires a careful assessment of the trade-offs between damage risks, ecosystem disruption, continued economic viability, and other factors.

The "Multiple Lines of Defense" strategy shows how coastal restoration measures, structural measures, and non-structural measures complement each other to protect communities from hurricanes. One way that the "rationales" used to formulate the initial alternative plans will be distinguished from each other is by the emphasis each plan places on one particular category or another. Ultimately, the features selected for feasibility study in each planning unit will likely include all three types of measures. Enclosure J contains a LACPR Project Management Plan describing the steps for arriving at this plan in the Final Technical Report.

Multiple Lines of Defense Strategy



(Graphic courtesy of Lake Pontchartrain Basin Foundation)

Based on preliminary technical investigations, the LACPR planning effort has identified a suite of components from which to create alternative plans. The plan formulation effort has identified two initial alternative plans which establish basic combinations of environmental, structural, and non-structural components. Two plan formulation rationales were applied to create the initial corresponding alternatives, Alternative Plans 1 and 2. Preliminary modeling screened five potential levee alignments to provide an initial basis for designing and gauging appropriate structural configurations to provide either the maximum or some varied level of risk reduction. Finally, the four categories of non-structural measures provide risk reduction where a variable level or no additional structural risk reduction might be warranted. This suite of components in combination with the iterative plan formulation process will allow for assessment of a broad range of possible solutions.

Alternative Plans 1 and 2

Alternative Plan 1 (described in Enclosure A) included pairing coastal restoration features with the maximum technically achievable level of structural risk reduction. To maximize risk reduction, the restoration features in this plan are designed to obtain the greatest extent of additional coastal landscape practicable without concern for sustainability. As a result, the restoration features packaged in this alternative plan focus on direct creation of marsh, restoration of critical ridges and shorelines, and management of hydrology.

Alternative Plan 2 (described in Enclosure A) recognized that not all areas would receive the maximum level of structural risk reduction. To supplement the limited structural risk reduction of this plan, the use of restoration features is expanded. This alternative employs the broad use of increased freshwater and sediment diversion and shoreline risk reduction to promote long-term wetland gain and sustainability.

A Vision for Success

Protecting Louisiana's citizens, natural resources, and industries from nature's most powerful storms presents one of America's greatest coastal resource challenges. A powerful hurricane striking the State of Louisiana produces extreme weather conditions requiring planners and designers to develop multiple lines of coastal defenses to protect vital low-lying assets and populations. A vision for success has emerged from the preliminary technical analysis of the LACPR team and others that have joined the debate about the future of coastal communities and wetlands in Louisiana. This vision shows that the long-term recovery of the region will be best established by using an integrated system of restored and sustainable coastal features, strong structural barriers and levees, and smart planning and rebuilding actions to protect lives and property.

The lessons of Hurricane Katrina show that a single line of levee defenses located adjacent to densely populated areas may be improved upon. Significant levee overtopping or floodwall failure led to catastrophic results in New Orleans. A better systems approach may be to fight storm surges on the outer fringe of populated areas with surge barriers and levees fronted by natural coastal features. This approach appears promising as a means of protecting New Orleans.

Coastal ecological features provide the outer line of defense against hurricane storm waves. Barrier island systems fronting the Gulf of Mexico absorb waves from approaching storms and help limit the amount of water that enters estuaries in advance of tropical systems. Marshes behind the islands and coastal fringe wetlands around large bays act as tidal and wave buffers protecting inland assets and communities. Forested wetlands in the upper reaches of estuaries provide further risk reduction through wind and surge reduction. Coastal ridges that follow old river and bayou banks also provide wave and wind reduction during storms. Collectively, these wetland and coastal features form an essential natural risk reduction barrier between the sea and cities. Without coastal features, the communities and industries of southern Louisiana would be exposed to direct wave action from the Gulf.

Despite the tragedies of Hurricanes Katrina and Rita, the LACPR team has identified some highlights of successes in these areas including two large-scale evacuations and a number of storm resistant homes. Those coastal homes that survived the storms used sensible building methods intended to withstand storm conditions. The strengths and weaknesses of these actions must continue to be evaluated and made more effective and widely applied. In the short-term, these types of actions have the most potential to establish a strong foundation for recovery because they can be implemented on an individual basis as citizens repair their homes and businesses. Establishing an environment for recovery that relies on individuals improving the resilience of their property to storms will complement government efforts to plan, design and build large-scale structural risk reduction features such as levees, storm barriers, and restored coastal features.

Sunset Over Louisiana Wetlands

Analysis performed for this report shows that coastal restoration, stronger building codes and effective evacuation plans are only part of a needed integrated solution to the hurricane threats facing southern Louisiana. In the case of the greater New Orleans area, a combination of low-lying topography, geographic position in an active river delta system adjacent to a large inland bay, and a concentrated urban population have created a significant risk scenario associated with hurricanes and storm surge flooding. Although this risk can be mitigated to some extent through measures of coastal restoration and non-structural measures, the magnitude of some storm surges is simply too large and therefore requires structural means to prevent catastrophic flooding. This is evidenced in computer model simulations of powerful hurricane landfalls that depict storm surge levels between 13 feet to 20 feet with waves as high as 12 feet along the south shores of Lake Pontchartrain. Under the severest storms, surge heights along the southern and western shores of Lake Borgne could reach 33 feet to 36 feet with waves 12 feet high. The current hurricane risk reduction system employs levees and floodwalls at elevations ranging from 12 feet to 18 feet and therefore is not capable of preventing surge or wave overtopping during the landfall of a powerful hurricane similar to the initial LACPR screening storm (i.e., the Probable Maximum Hurricane). Surges of this magnitude would overwhelm the levee systems and likely result in damages to the New Orleans area even greater than witnessed during Hurricane Katrina.

Developing a Comprehensive Plan and Decision Support Information

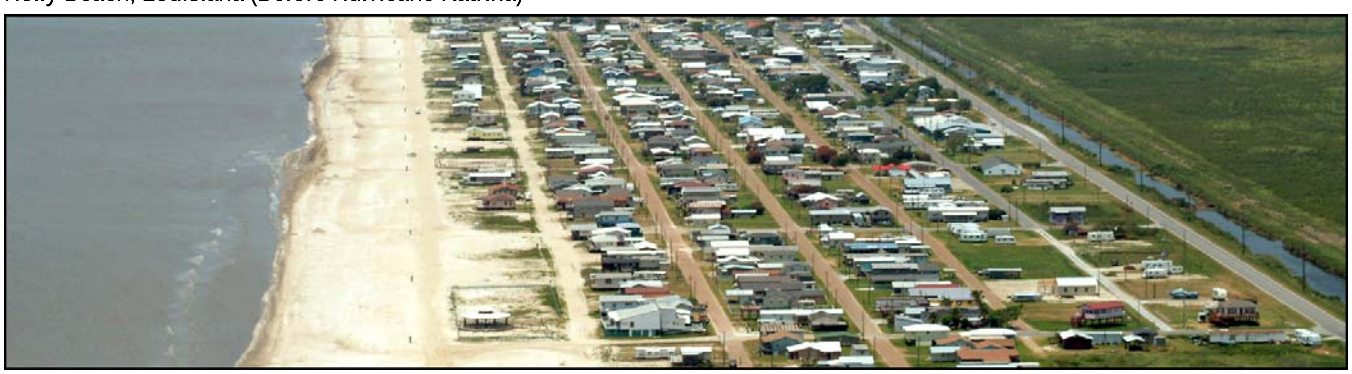
Despite opposition in the 1970s, one measure more recently identified as a potentially publicly-acceptable alternative is the Lake Pontchartrain Basin Barrier System. However, significantly greater detail is needed to fully develop, evaluate, and recommend this project for further consideration. Also, other components of enhanced hurricane risk reduction and coastal restoration in South Louisiana will continue to be developed including measures for areas beyond greater New Orleans. Decision-makers need a well-reasoned base of supporting information regarding populations and assets at risk, project costs, consequences of inaction, and other factors before making a decision regarding full implementation of any system or other features for the rest of the coast. The LACPR team will define these plan options in detail to remove uncertainties and provide information necessary to further determine the Federal interest in future plans and projects.

In addition, the Corps of Engineers IPET and LACPR teams have identified a new risk-based assessment methodology for developing hurricane risk reduction plans that would include valuation of consequences to populations and assets at risk. This new methodology is emerging from post-Katrina forensic efforts and is being proposed as an improved approach for future engineering work and policy direction. In short, the methodology seeks to transform development of hurricane risk reduction plans from focusing on a planning approach based upon cost benefit analysis to a risk-based assessment. The methodology will need further development by leading experts and vetting through a rigorous independent review for verification. The LACPR final report will support the development of the methodology and incorporate it into a range of information to be presented to decision-makers.

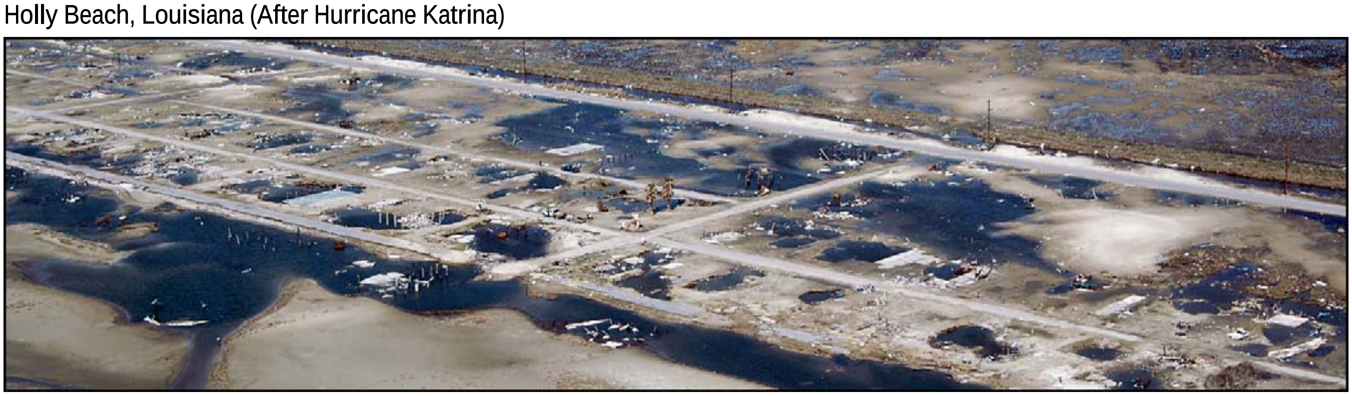
The Corps of Engineers LACPR team, working with the State of Louisiana, will obtain information from the following areas:

- **Risk Assessment Workshop.** Through a series of expert workshops develop details of the new risk-based methodology for assessing hurricane risk reduction needs. Seek independent technical review of the methodology before adopting it for application in populating a criteria analysis matrix for decision-making.
- **Design and Analysis Framework.** Develop and employ site selection rationale and engineering assessment techniques to devise the features required for a Lake Pontchartrain Basin Barrier System. The challenge of designing a hurricane risk reduction system capable of protecting the area from nature's most powerful storms is formidable. Rigorous design standards, independent technical reviews, and well-reasoned decision support frameworks are essential.
- **Design Concept Competition.** Host a design concept competition to allow broad-scale input into approaches for designing large basin systems risk reduction. The adoption of competitive practices has been successfully employed in other large engineering efforts and may have merit in this case.
- **Plan Integration.** Integrate plans for restoring coastal habitat features that complement hurricane risk reduction including quantification of storm surge reduction benefits. A levees-only approach to hurricane risk reduction may ultimately fail if the encroachment of the Gulf of Mexico continues at current rates. Restoring coastal features supports the multiple lines of defense strategy and offers environmental benefits and cost reductions in long-term maintenance.
- **Environmental Impact Assessment.** Assess environmental impacts associated with construction of the projects recommended for further design analysis. The team has initiated a PEIS that will allow for public involvement and comment in the development of these plans. In addition, the PEIS is intended to advance the identification of problems and seek innovative solutions to minimize and offset environmental impacts associated with hurricane risk reduction.
- **Communications Plan.** Maintain frequent communications across all levels of the Federal government and local sponsors involved in hurricane recovery planning. A well-informed audience is best prepared to assist in decision-making and focusing of limited resources and tight completion schedules. Opportunities for resolving roadblocks and leveraging additional resources are added benefits to team communications.

Holly Beach, Louisiana (Before Hurricane Katrina)



Holly Beach, Louisiana (After Hurricane Katrina)



Steps to the Final Technical Report

The Preliminary Technical Report defines the need for a framework to inform decisions as to future recommendations and captures the work performed to date concerning the effort to provide for "Category 5" hurricane risk reduction options for coastal Louisiana. The following sections describe the additional design and analysis that will be completed for the Final Technical Report.

Continued Technical Assessment

The information presented in this Preliminary Technical Report relied on a single screening storm that satisfied the "Category 5" criteria. Because of the extreme event used to set design elevations for this initial phase of technical study, levee elevations required to block storm surges stretch the capability of conventional levee design. Extraordinary methods such as deep soil mixing coupled with high strength geotextiles are required to satisfy the height and stability requirements for structures located on the soft soil foundation conditions that exist in South Louisiana.

The design requirements generated in this first phase of study illustrate to some that it may not be practical to employ this degree of risk reduction for the entire State. Construction of a continuous, impenetrable barrier would be expensive and seems an unrealistic solution for colossal storm surge events at all locations. A wiser approach would seem to be to manage storm surges rather than to simply attempt to completely repel them. In areas where there are ample storage basins behind levees, engineers will examine the possibility of allowing controlled overtopping of levees during the peak hours of the most severe storms. Such a strategy could relieve water pressure on the hurricane risk reduction system while protecting lives and property. Levees and surge barriers can prevent flood waters from entering areas but blocking surge at one point on the coast during a storm may result in raising surge levels at other points. As such, the LACPR team will need to develop a risk reduction system that allows for management of storm surges. As this effort moves forward, the engineering and design team is pursuing several independent but coordinated efforts to address the problems regarding the management of storm surge. In addition to modeling two additional screening storms, the LACPR team anticipates conducting numerous additional analyses and investigations for the evaluation of alternative measures and plans to be considered in the Final Technical Report.

The assessment of coastal restoration features and storm surge reduction is linked to ongoing technical efforts associated with the engineering analysis for the Final Technical Report. The effect of coastal restoration features will be related to the storm surge analysis for both historical and theoretical storms and the movement and storage of these tidal volumes. These environmental features will be assessed for their specific contributions to ecosystem output and benefits through the application of a habitat measurement tool. Still other assessments of features to determine and forecast systemic hydrologic and environmental response will use an ecologic modeling tool.

Lake Pontchartrain Levee in Kenner, Louisiana

Storm Surge Storage

Preparation of alternative plans has focused on providing an impenetrable barrier to completely halt the storm surge and waves of storms. The result is a barrier with elevations larger than any existing levee, in some locations by a factor of more than two. A cursory examination of the various alignments under study reveals undeveloped natural areas with potentially significant storage capacity on the protected side of the barrier. Where storm surge water can be stored, full height impenetrable barriers would not be necessary. Additionally, allowing water to move from the flood side to the protected side will reduce the volume of water to be repelled by the barrier, which may allow for lower barrier elevations. The resulting design would be less expensive to build and be less imposing on the landscape.

Engineers are looking at ways to manage the storm surge by incorporating the ability to allow some part of the peak portion of the storm surge to overflow at selected "spillway" locations so that these volumes of water can move into designated storage areas. These spillways would allow a calculated volume of water to be stored inside the risk reduction system instead of being forced to pile up against a much higher levee. The intent here is to be able to reduce the heights of the adjacent barrier levee.

Under this scenario, additional levee work may be required to protect against the added stage caused by the controlled overflow. In some cases, the cost per mile of two parallel levee alignments of lesser elevation is less costly than one that prevents overtopping. Engineers are seeking to limit the heights of the levee and spillway system to provide for the maximum risk reduction at the least cost. There are a number of locations where this concept is being examined.

Storm Surge Transfer Across the Mississippi River

As noted previously, the construction of a tall, impenetrable barrier may not be the wisest way to resolve the storm surge problem at all locations. Hurricanes Katrina and Rita were especially harsh on the slim strip of developed land along the east and west banks of the Mississippi River from Belle Chasse to Venice, Louisiana. Along the river, levees block the effects of hurricane storm surge attacking from both sides of the Mississippi River and from estuaries.

Investigations for the Final Technical Report will consider the effects of hurricane flooding from the Mississippi River. Raising the Mississippi River levees to elevations needed to prevent hurricane storm surge flooding will be a part of any comprehensive plan. If storm surge can be directed away from or past the levees, stages could be lowered and a more feasible levee design may result; however, in some areas storage on the protected side of levees is severely limited.

To manage the height of storm surges that stack up against the Mississippi River levees below River Mile 70 Above Head of Passes, engineers are investigating the use of spillways that would allow surge to transfer from one side of the river to the other (e.g. from Breton Sound to Barataria Bay or vice versa). A review of ADCIRC model runs simulating storm surge effects shows that a continuous levee system along the Mississippi River will completely block storm surges approaching from either direction. The incorporation of spillways at selected critical locations may allow a controlled volume of storm surge to pass from one side of the Mississippi River ridge to the other. Adding spillways might make it possible to reduce levee heights for many miles of the hurricane risk reduction system. The use of spillways may aid in providing the greatest level of risk reduction for the greatest number of citizens. In addition, selective siting of spillways for surge transfer and reduction may also augment development of freshwater and sediment diversion corridors for coastal restoration purposes.

Wave Wash into Wetlands on the MRGO

Hollow Core Levees

Significant expense and design obstacles of the barrier system will be addressed more thoroughly in the Final Technical Report. Engineers recognize that the heavy loads imposed on the foundation by a large levee would require high costs to improve the local soils. The source for the large quantities of borrow material required to construct a large levee system is also a concern. One innovative solution suggested during the Engineering Technical Approaches and Innovations Workshop is the concept of constructing a hollow core levee. There are several ways in which this type of barrier could be constructed involving the use of precast concrete elements. All have the advantage of reducing the quantity of soil needed to build the levee, which simultaneously reduces the weight of the overburden on the foundation soils. In addition to improved constructability there is also the potential for significant cost savings and reduced environmental impacts. Some significant design issues remain to be addressed and will be investigated and reported in more detail in the Final Technical Report.

Foundation Soil Improvement by Deep Soil Mixing

For the Preliminary Technical Report, engineers have already completed a preliminary design analysis of improving existing foundation soils by using deep soil mixing technology. However, this technology has limited real-world use in both hurricane risk reduction systems and in the especially poor soils of Southeast Louisiana. A number of general assumptions were made in this first phase of the project that will be further investigated and refined for the Final Technical Report. Of most value would be a full-scale field test of a typical levee section. Engineers will further examine the design parameters and field techniques to provide the optimal recommendation for deep soil mixing applications in coastal Louisiana.

Habitat Assessment

The Wetland Value Assessment (WVA) is a quantitative, habitat-based ecological quality assessment methodology. Developed for use in prioritizing project proposals for CWPPRA, the WVA quantifies changes in fish and wildlife habitat quality and quantity that are projected to emerge or develop as a result of a proposed wetland enhancement project (or a project that impacts wetlands). The results of the WVA are measured in Average Annual Habitat Units which reflect the quantity and quality of habitat gained and/or impacted.

The WVA has been developed strictly for use in comparing proposed projects; it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. It is a modification of the Habitat Evaluation Procedures developed by the U.S. Fish and Wildlife Service. There is a notable difference between the two methodologies: The Habitat Evaluation Procedures generally uses a species-oriented approach, whereas the WVA uses a community-based approach.

Some of the wetland communities evaluated by the WVA include fresh marsh (including intermediate marsh), brackish marsh, saline marsh, and cypress tupelo swamp. The WVA has been developed to determine the suitability of Louisiana coastal wetlands for providing resting, foraging, breeding and nursery habitat to a diverse assemblage of fish and wildlife species. Since the WVA is designed to function at a community level, it attempts to define an optimum combination of habitat conditions for all fish and wildlife species utilizing a given wetland type over a year or longer.

Ecosystem Response Modeling

The Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) model, or "desktop" model, developed for LCA was constructed by assembling a system that could evaluate basin scale restoration alternatives using existing ecosystem modeling tools for coastal Louisiana. Modeling tools that were immediately available, and that could link geophysical, geomorphological and ecological responses of coastal ecosystems to a variety of measures were employed in developing this tool. Four types of modeling/evaluation tools where utilized.

- Numerical models – represents the highest level of sophistication in ecological modeling.
- Less sophisticated hydrodynamic models, such as box models – predict salinity, hydroperiod, and possibly sediment distribution over longer time scales, with more coarse spatial resolution.
- Monitoring and feasibility studies (empirical information) – to statistically estimate ecosystem response to various levels of river resources.
- Expert scientific judgment based on clearly defined conceptual models that link environmental drivers to ecosystem responses.

The numerical and hydrodynamic models are referred to as 'simulation modeling' in the LCA Ecosystem Model. The other two model types rely less on computational analysis and more on empirical relationships and are referred to as 'desktop modeling'. The distinction between these two approaches is that products from simulation models are based more on processes; products from desktop models are based more on statistical assessments of relationships.

Foggy Marsh Near Caernarvon, Louisiana

In order to evaluate the outputs and benefits of a particular alternative grouping of measures, the CLEAR model employs hydrodynamic and ecological models, benefit protocols, and agency and academic expertise to generate baseline information about the effects of the combinations of engineered restoration features. Outputs and benefits include measures of ecosystem function and response such as: land building, habitat switching, primary productivity of land and water, removal of nitrogen from Mississippi River water, and habitat use of wetlands by 12 coastal fish and wildlife species. The outputs/benefits cover an array of ecosystem attributes and functions, and they provide a means of comparing complex patterns of ecosystem change, both in space and time.

Real Estate Assessment

The advancement of plans discussed in this Preliminary Technical Report into project stages would require a substantial amount of land from a significant number of landowners. In addition to levee rights-of-way, real estate interests for construction would be required for borrow areas, access roads, levees, control structures, pump stations, and coastal restoration features. Real estate costs will be based on the estimated acreage and number of landowners for each alternative, along with any benefits which may have to be paid under the Uniform Relocation Assistance and Real Property Acquisition Policies Act (P.L. 91-646). A Real Estate Plan incorporating the requirements of Chapter 12 of Engineering Regulation 405-1-12 will be included as an appendix for the Final Technical Report. The Real Estate Plan will present a detailed analysis of the land, acquisition and relocation costs, and other real estate issues required for constructing associated projects.

Costs

The eighth element of the decision framework is a series of matrices to estimate the cost of each of the scaled alternatives. Costs estimates will consider the following potential costs for each of the relevant features:

- Elements of this effort attributable to respective features, if any
- Engineering and design studies for specific measures
- Construction
- Operations
- Maintenance
- Reconstruction
- End of engineering life rebuilding or disposition
- Consequences costs
- Opportunity costs

Developing detailed cost estimates for a project of this size and complexity requires the expenditure of resources and time far greater than allowed to produce the Preliminary Technical Report. As analysis proceeds to the next level, more definitive alignments and their associated costs will be prepared.

Public Involvement

The Corps of Engineers is committed to working with members of the public, local governments, stakeholder organizations, and other groups. Outreach and communication plans, specific to LACPR, will stress public involvement and interaction. Upon release of the Preliminary Technical Report, the Corps of Engineers will seek further input from interested individuals and groups. Formal comment periods and public meetings will be held in early Spring 2007 to accompany the release of a draft PEIS and draft Final Technical Report. Additional comments will be taken with the release of the Final PEIS and again with submittal of the Final Technical Report to Congress in December 2007. Up-to-date information is frequently made available to the public on the LACPR webpage at www.lacpr.usace.army.mil.

Public outreach and involvement must be integrated with all steps of the plan formulation process. The primary goal of public outreach and involvement is to provide information and gather public input that could assist decision-making during the project development phase. The public plays an important role in the NEPA process. These efforts provide for an early and open public process for determining the issues, resources, impacts, and alternatives to be addressed in a PEIS for the LACPR Final Technical Report.

Public Scoping Meeting in New Orleans, Louisiana

NEPA Scoping Meetings

Previous efforts to build a barrier system to protect New Orleans from hurricane storm surge were abandoned in the 1970s after legal challenges associated with NEPA and a subsequent significant increase in the cost of the barrier system in comparison to a high-level levee plan. In compliance with NEPA and to ensure that environmental impacts are fully considered during the project development process, the Corps of Engineers is producing a PEIS for the Louisiana Coastal Protection and Restoration project. During a series of public meetings from March 9 – 16, 2006, conducted in four cities in South Louisiana (New Orleans, Thibodaux, Lake Charles, and Lafayette), the Corps of Engineers solicited public comments on the LACPR project. Approximately 370 people attended the four meetings and nearly 680 comments have been received and recorded to date. The Scoping Report for the LACPR PEIS outlines the project background and scoping process and summarizes key issues identified by members of the public during the initial scoping period, which began on March 5, 2006, and ended on March 27, 2006. The Scoping Report including written comments from citizens, local governments, businesses, and natural resource agencies is provided in Enclosure K.

The Draft PEIS document will be available for public review and comment for a 45-day period that is currently scheduled to begin in May 2007. During the 45-day review period, public hearings will be held to receive comments and address questions concerning the Draft PEIS. Additional public comment will be taken upon release of the final report.

Top Five Themes from NEPA Scoping Meetings:

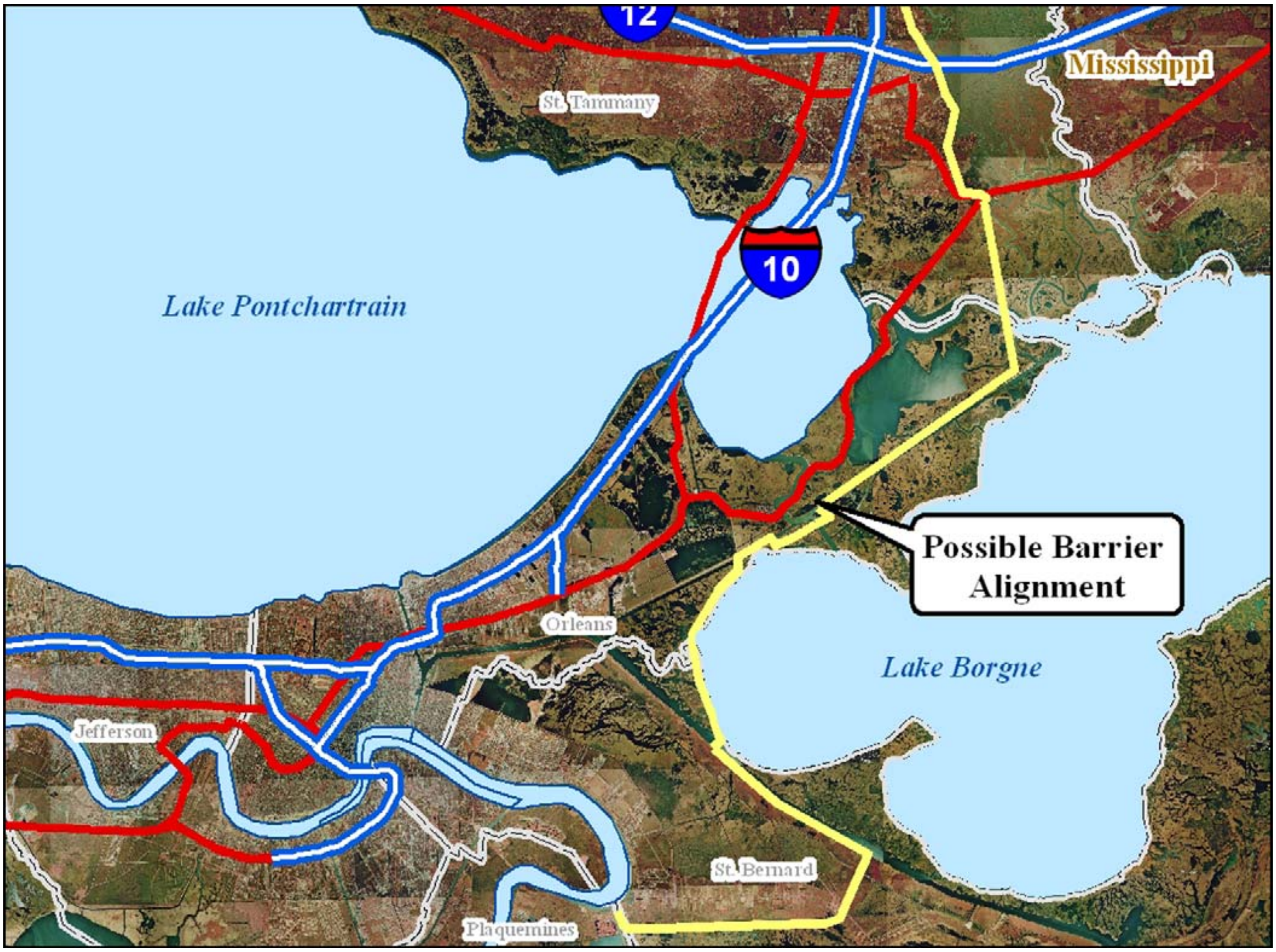
1. The LACPR plan should incorporate local knowledge and concerns.
2. The restoration of marshes, wetlands, and natural coastal barriers is a key protection feature.
3. Coastal protection should address saltwater intrusion, subsidence, and sediment delivery.
4. Comprehensive, multidisciplinary, and efficient planning is required for success.
5. The Corps of Engineers should use innovative technology and consider creative solutions when developing alternatives.

Other Public Outreach and Involvement

The LACPR project has received extensive media coverage. In addition to the scoping meetings, public meetings have been held as requested by communities such as Houma and Larose. Educational publications have been produced and distributed at the meetings. See Enclosure L for a complete list of public outreach and involvement activities that have taken place to date. In addition, project information is provided on a web page found at www.lacpr.usace.army.mil. The LACPR website is kept updated with maps and other information relative to the alternatives, educational materials, news releases, presentations made, and input provided by the public. A "Comment" link is available for interactive communication between the public and team members.

Salt Marsh Along Bayou Lafourche

Possible Lake Pontchartrain Basin Barrier System



A system of restored wetlands, stronger levees, and surge barriers east of New Orleans may offer the best approach for protecting communities around the Pontchartrain basin.

Innovative Design Concepts

We are seeking innovative concepts for addressing the comprehensive range of risk reduction measures that are the subject of the LACPR reports. This will include a request for interested parties to submit innovative designs and concepts for hurricane risk reduction measures. The public is invited now to propose innovative conceptual approaches so that they may be considered in interim reports or in the Final Technical Report, as appropriate. Once the new decision framework is available, the USACE-Louisiana CPRA team will solicit recommendations from interested parties as how to best consider innovative approaches for hurricane risk reduction strategies for South Louisiana.

Continuing Coordination with Other Programs

The LACPR effort will continue to coordinate with the ongoing efforts of the State CPRA master planning effort, LCA Plan, CWPPRA Program, and the Mississippi Coastal Improvement Projects effort. The Corps of Engineers has signed a memorandum of understanding with the CPRA committing to the close coordination of these two risk reduction and restoration projects. This coordination will ensure that conflicts in the restoration purpose of the LCA Plan and CWPPRA projects are avoided and that technical and analytic efforts and tools developed by these programs are capitalized upon in the LACPR initiative. Likewise, coordinating with the State of Mississippi's risk reduction and restoration plans will help avoid unintended adverse impacts and foster sharing of technical findings.

Risk Assessment Methodology

Using the probability of storms and level of risk reduction to analyze hurricane risk reduction levels instead of Saffir-Simpson damage categories offers a more realistic and understandable approach for engineers, government leaders, and the public. A new risk-based assessment methodology is being developed for use in preparing the LACPR Final Technical Report. The methodology will assess alternative hurricane risk reduction plans and would produce valuation information describing the risks and consequences for various populations and assets along the coast under different planning scenarios and solution options.

Any category of economic, environmental, or social output, can be assessed for risk. Risk is a reflection of the product of the probability of some magnitude of adverse event occurring and the consequences of that event on an output. Probability and consequences are the measurable factors used to identify risk. In the case of storm surge reduction, actions can not be taken that alter the probability of the events. Actions can be taken to alter the consequence related to certain events. However, short of taking those actions that eliminate all potential surge related impacts, the ultimate consequences to a particular output over the full range of events may not be altered. Ultimately, most risk reduction solutions are directed at altering the relative relationship between probability and consequence.

This new risk assessment methodology is emerging from post-Katrina forensic efforts and is being proposed as an improved approach for future engineering work. Although the method shows promise, further development by leading experts and a rigorous independent review is still needed. The team will conduct a series of expert workshops to develop details of this methodology. The methodology will undergo independent technical review and be vetted through the vertical team before it will be adopted for assessing hurricane risk reduction needs and final decision-making. A detailed report on the methodology will be prepared following the workshop and distributed for review in September 2006.

The LACPR final report will support the development of the methodology and incorporate it into a range of information to be presented to decision-makers. Inputs into the methodology will be presented in a decision-support matrix to help inform development of recommendations. Critical information sectors for the matrix will include storm surge, environmental benefits and impacts, design details, costs, protected and at-risk populations, concentrated assets and other factors. The analysis will be designed to identify water level risks inside and outside of risk reduction systems and couple it with projected economic damages associated with inundation levels. The matrix will be integrated with GIS for graphical presentation of results in multiple formats including scales of coastwide, watershed level, political subdivision, census-tract, and risk reduction basins or polders. Multiple-scenarios will be evaluated including scaled levels of development and recovery and modification of scenarios that would allow for gauging of unknowns such as sea level rise and subsidence variations.

The Coastwide Planning Objectives described in the plan formulation section provide a framework for establishing appropriate measurable, risk-related evaluation and screening criteria. These objectives identify areas of desirable basic system function for which measurement criteria can be set. For those system functions related to ecosystems, there are numerous parameters for which measurement tools have been previously developed and applied. For functions related to risk reduction systems, there are clearly understood and measurable parameters that relate strictly to the performance of structural risk reduction measures and the resultant consequences associated with lack of performance. Additional criteria are needed to address measurement of the effect of risk reduction measures on ecosystem function and the contribution that ecological features have on storm surge reduction and sustainability.

Numerous parameters are being considered in developing these criteria. The fundamental systemic connection between the risk reduction systems and ecosystems is their relationship to hydrology. The examination of this hydrologic relationship can incorporate elements of quantity, magnitude, and relative distribution over time for any parameter that can influence or that may be influenced by this relationship. Examples of these influences include the effect of wetland quantity or location on surge; the value of these effects based on their distribution over time; the availability and timing of water, sediment and nutrient resources as affected by the location and operation of a structural risk reduction system. Development of criteria and parameters for assessing those crossover functions and their relative effect on economic and environmental consequences will be addressed before completion of the Final Technical Report.

Following the precise instruction of the legislation, all design work has been based on hydrodynamic modeling results of a single, massive hurricane that is classified as a "Category 5" storm on the Saffir-Simpson Scale. The result of this analysis produces a design for risk reduction against a single storm event of indeterminate recurrence. For critical systems, our counterparts in The Netherlands and elsewhere use a risk-based approach that provides recurrence and a rational basis for establishing flood risk reduction policies. The superior utility of this approach is apparent and warranted. For the Final Technical Report, the LACPR team is not limiting its efforts to a single screening storm but is moving to a risk-based approach. This approach will enable decision-makers to look at the flood risks associated with the various levee alignments and make informed decisions about the degree of risk reduction that can be justified in the national interest.

Technical Peer Reviews

The LACPR team will continue to engage neighboring Corps of Engineer districts along the Gulf Coast and other parts of the country and Planning Centers of Expertise for serving as technical peer reviewers. Both the internal and external peer reviews will be conducted periodically throughout the effort to verify the work and products of the LACPR team. These reviews for the Preliminary Technical Report have been beneficial for identifying key issues and information to be further investigated and better communicated in the Final Technical Report. The external peer review team, composed of individuals solicited from national science and engineering organizations have produced a document of their review of the Preliminary Technical Report. This document is included in Enclosure M. The external peer review team will continue to participate in the review process throughout the preparation of the Final Technical Report.

Cows Stranded by Floodwaters

Osprey in Cypress Tree in West Bay

Views of the State of Louisiana

The State of Louisiana indicated its strong support for an expeditious completion of design activities for a number of specific projects, components, or programs that would lead to construction authorization. These projects are composed of coastal restoration, new levee systems, and storm surge barriers, and are deemed to be of highest priority and supported by the greatest amounts of existing information, including the following:

- Lake Pontchartrain Basin Barrier Protection.
- Mississippi River Gulf Outlet (MRGO) Modification.
- Barataria Barrier Islands Restoration.
- Morganza to the Gulf of Mexico Hurricane Protection.
- CWPPRA projects in Southwest Louisiana.

KATHLEEN BABINEAUX BLANCO
GOVERNOR

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(225) 342-7015

Lieutenant General Carl A. Strock
Commander and Chief of Engineers
U.S. Army Corps of Engineers
441 G Street NW
Washington, D.C. 20314

Dear General Strock:

The recent hurricanes ravaged the coast of Louisiana and brought unprecedented loss of life and destruction to our state. While these events undoubtedly scarred our people, they also strengthened our resolve to address the vulnerabilities of our coastal ecosystem and fortify our defenses against future storms.

The American people, the Congress and the President responded generously in the aftermath of these disasters and the people of Louisiana are extremely grateful. We are finally on the path to true recovery and rebuilding. As leaders, now we must turn our attention to the future.

The Congress exhibited its leadership in mandating the U.S. Army Corps of Engineers to complete a Louisiana Coastal Protection and Restoration Plan that would be done in cooperation with the state of Louisiana and would incorporate coastal restoration into a comprehensive hurricane protection plan. At the same time, the Louisiana State Legislature showed its leadership by mandating the Coastal Protection and Restoration Authority to complete a Comprehensive Coastal Protection Master Plan that would fully integrate coastal restoration with hurricane protection.

In response to this direction, the State of Louisiana and the Corps of Engineers have created an integrated planning team and memorialized their partnership in an official Memorandum of Understanding. The critical work being done on both plans benefits from this seamless partnership and I am pleased with the high level of cooperation.

We agree with the intent of Congress that critical features of the comprehensive plan be submitted for "authorization as soon as practicable". This language indicates an understanding of the urgent need to protect portions of coastal Louisiana before completion of a comprehensive plan in another 18 months. Congress clearly states in its direction this report be prepared "exclusive of normal policy constraints", which clearly recognizes that a business-as-usual approach to these issues is not acceptable.

Therefore, the state requests that Congress consider action on five urgent components of the plan. We know that existing levels of protection are inadequate and that more data will not change that finding. We are confident these recommendations will be included in any completed comprehensive plan. Future analyses are not likely to change the decision to include these features, although additional design work is needed to refine alignments and specific engineering approaches. We consider these projects fundamental to reduce future risk.

Proposed Expedited Components

MRGO

The State of Louisiana has clearly expressed its official policy regarding the future of the Mississippi River Gulf Outlet (MRGO). Our people have spoken, our Legislature has made its will clear, and my Advisory Commission on Coastal Protection, Restoration and Conservation has recommended the immediate closure of this channel.

MRGO has compromised the safety of countless communities and contributed to the loss of vital coastal marsh areas. Certain technical aspects must be determined and assistance to industry to maintain an even flow of commerce is required. However, the closure of the MRGO must ensure that communities are safe and our ecosystems are protected from further saltwater intrusion and coastal land loss. The state recommends that the Corps moves quickly to close the MRGO and that this is done in partnership between the state and Federal government.

Although funding was allocated in the 4th Emergency Supplemental Appropriations Bill (P.L. 109-234) for a six-month report on the de-authorization of MRGO to deep draft navigation, the state remains concerned about the urgency of closing this channel. We request the Corps to budget for the closure of the MRGO in Fiscal Year 2008 so there is no lag time between the completion of the report and actions needed to close the channel.

Hurricane Barrier East of the Mississippi River

The devastation caused by Hurricane Katrina to the metropolitan area of New Orleans disrupted the lives of hundreds of thousands of Louisianans and threatened the long term economic viability of the city and state. In spite of the extraordinary efforts by the Federal government to restore the level of protection and to complete authorized projects, the risk of flooding from major storms is still unacceptable. A barrier alternative east of the Mississippi River will provide a first line of hurricane protection defense for a major metropolitan area, working in concert with existing projects.

Studies demonstrate great promise for the feasibility and construction of such a protection system, but further evaluation must confirm the barrier plan as the optimal solution. Therefore the state of Louisiana recommends the initiation of detailed design and analysis and environmental compliance for a hurricane barrier east of the Mississippi River.

Morganza-to-the-Gulf Hurricane Protection Project

One of the most unprotected areas of coastal Louisiana sits squarely in the center of our state's coast. Regrettably, the key to protecting the south central portion of our state remains tied to passage of the Water Resources Development Act (WRDA). This project has a completed Chief of Engineer's Report and has been available for authorization since 2002. However, there is significant doubt that Congress will pass a WRDA bill this year. Therefore, the State recommends the immediate authorization and continuation of

PED for the Morganza-to-the-Gulf Hurricane Protection Project as described in the Chief's Report signed on August 23, 2002. In addition, the Congress should continue to evaluate greater levels of hurricane protection as part of the ongoing LaCPR efforts.

Barataria Basin Barrier Shoreline Restoration

The State recommends the completion of a feasibility-level decision document and continuation of PED for the Barataria Basin Barrier Shoreline restoration project, as described in the Louisiana Coastal Area (LCA) Program Chief's Report signed in January 2005.

Southwest Louisiana Protection and Restoration Act Projects

The southwest area of Louisiana was devastated by Hurricane Rita and remains unprotected. The State recommends the construction of specific Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) projects in Southwest Louisiana. Specifically, the State recommends the immediate authorization of projects that have completed decision documents and that would restore wetlands destroyed by Hurricane Rita. Undoubtedly, these projects would provide wetland buffers to protect communities from direct exposure to hurricane storm surges.

The Louisiana Coastal Protection and Restoration Authority and its planning team have worked closely with your staff to develop these recommendations to ensure they reflect fiscal responsibility while aggressively moving to address critical needs. They reflect the official policy of the State of Louisiana and are of the highest priority, essential to the lasting protection and restoration of coastal Louisiana – America's Wetland. Action on these components should not wait another 18 months before being considered.

We are pleased the Corps recognizes the complexities and uncertainties inherent in this planning process and is developing new tools for risk-based decision making. However, as we go forward in jointly developing this new process, we must avoid waiting too long for perfect knowledge. We must act aggressively to protect our citizens and a collapsing coastal ecosystem.

Thank you for your support. I look forward to our continued close partnership as we move forward in the protection of an area so critical to the nation.

Sincerely,

Kathleen Babineaux Blanco

Kathleen Babineaux Blanco
Governor
State of Louisiana

ADCIRC ....ADvanced CIRCulation Hydrodynamic Model
BFE ....Base Flood Elevation
BTNEP ....Barataria-Terrebonne National Estuary Program
CIAP ....Coastal Impact Assistance Program
CLEAR ....Coastal Louisiana Ecosystem Assessment and Restoration
CPRA ....State of Louisiana Coastal Protection and Restoration Authority
CWPPRA ....Coastal Wetlands Planning, Protection and Restoration Act
DNR ....Louisiana Department of Natural Resources
EIS ....Environmental Impact Statement
EPA ....Environmental Protection Agency
ERDC ........................U.S. Army Corps of Engineers Research and Development Center
FEMA ....Federal Emergency Management Agency
GIS ....Geographic Information Systems
GIWW ....Gulf Intracoastal Waterway
IPET ....Interagency Performance Evaluation Task Force
LACPR ....Louisiana Coastal Protection and Restoration
LCA ....Louisiana Coastal Area
LIDAR ....Light Detection and Ranging
LRA ....Louisiana Recovery Authority
MMS ....Minerals Management Service
MRGO ....Mississippi River Gulf Outlet
MR&T ....Mississippi River and Tributaries
MsCIP ....Mississippi Coastal Improvements Program
NED ....National Economic Development
NEPA ....National Environmental Policy Act
NOAA ....National Oceanic and Atmospheric Administration
NRCS ....Natural Resources Conservation Service
P&G ....Principles and Guidelines
PEIS ....Programmatic Environmental Impact Statement
PMH ....Probable Maximum Hurricane
SELA ....Southeast Louisiana Urban Flood Control Project
SPH ....Standard Project Hurricane
WVA ....Wetland Value Assessment

100-year Level of Risk reduction

Design based on a flood elevation that statistically has a 1% chance of being equaled or exceeded in any given year. Similarly, a 50-year level of risk reduction is based on a flood elevation that has a 2% chance of being equaled or exceed in any given year (divide 1 by the return period and multiply by 100 to get the percent chance).

ADCIRC

The ADvanced CIRCulation hydrodynamic model is a finite element hydrodynamic circulation numerical model for the simulation of water level and current over and unstructured gridded domain. The ADCIRC model is used to calculate the design still water level in storm events.

Base Flood Elevation

The elevation of a flood having a 1% chance of being equaled or exceeded in any given year. BFE is a standard requirement for certification that FEMA uses in issuing National Flood Insurance policies to property owners.

Category 5 Hurricane

A storm on the Saffir-Simpson Hurricane Scale having winds greater than 155 mph (135 knots or 249 km/hr). Storm surges are generally greater than 18 feet above normal. Only three verified Category 5 Hurricanes have made landfall in the United States since recordkeeping began: The Labor Day Hurricane of 1935 (Florida Keys), Hurricane Camille in 1969 (Mississippi and Louisiana), and Hurricane Andrew in August 1992 (Florida and Louisiana).

Design Storm

A theoretical storm used as a method for estimating storm-related risks and developing engineered structural risk reduction systems such as levees and floodwalls. Types of storms that may potentially result in design criteria include the Standard Project Hurricane, Probable Maximum Hurricane, Maximum Possible Hurricane, 100-year storm event, etc.

Empirical Simulation Technique

Empirical Simulation Technique is a statistical procedure for simulating life-cycle risk analysis of events such as storms and their corresponding environmental impacts. The technique is based on bootstrap resampling-with-replacement, interpolation, and subsequent smoothing of observed and/or computed site-specific historical events. The Modified Empirical Simulation Technique consists of a revised plotting estimation methodology for plotting historical storms for the New Orleans area in the EST.

Initial Screening Storm

The initial screening storm used for hydrodynamic modeling in the Preliminary Technical Report is based on the probable maximum hurricane (PMH) as documented in NOAA's Technical Report NWS 23 (1979). The PMH criteria for the Louisiana coast describe a storm of Category 5 intensity on the Saffir-Simpson Scale. This PMH has a central pressure of 890 mb; radius to maximum winds of 11 nautical miles (similar to that of Hurricane Camille); forward speed of 10 knots; and maximum sustained winds of approximately 166 mph.

Joint Probability Method

The Joint Probability Method is a statistical tool involving an assumption of independence of storm parameters so that the combined probability of a particular hurricane is the product of the probabilities of each of the governing parameters. These parameters include forward speed, storm radius, central pressure depression, and storm position; a dependence on track angle is assumed and accounted for by separation of the storm into directional families.

Maximum Possible Hurricane

The estimated characteristics of the theoretical, most extreme hurricane that could threaten South Louisiana.

Probable Maximum Hurricane (PMH)

A hypothetical hurricane that might result from the most severe combination of hurricane parameters that is considered reasonably possible in the region involved, if the hurricane should approach the point under study along a critical path and at optimum rate of movement. This estimate is substantially more severe than the Standard Project Hurricane, but less severe than the Maximum Possible Hurricane criteria. See Initial Screening Storm definition for the PMH criteria.

Return Interval

Average period of time between occurrences of a given hurricane or tropical storm event.

Saffir-Simpson Hurricane Scale

The Saffir-Simpson Hurricane Scale is a 1-5 rating based on a hurricane's intensity at a given point in time. This scale is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline in the landfall region.

Standard Project Hurricane (SPH)

A hypothetical hurricane intended to represent the most severe combination of hurricane parameters that is reasonably characteristic of a specified region, excluding extremely rare combinations. It is further assumed that the SPH would approach a given project site from such direction, and at such rate of movement, to produce the highest hurricane surge hydrograph, considering pertinent hydraulic characteristics of the area. Based on this concept and on extensive meteorological studies and probability analyses, a tabulation of "Standard Project Hurricane Index Characteristics" was mutually agreed upon by representatives of the U.S. Weather Service and the Corps of Engineers (NOAA 1979).

Synthetic Storm Method

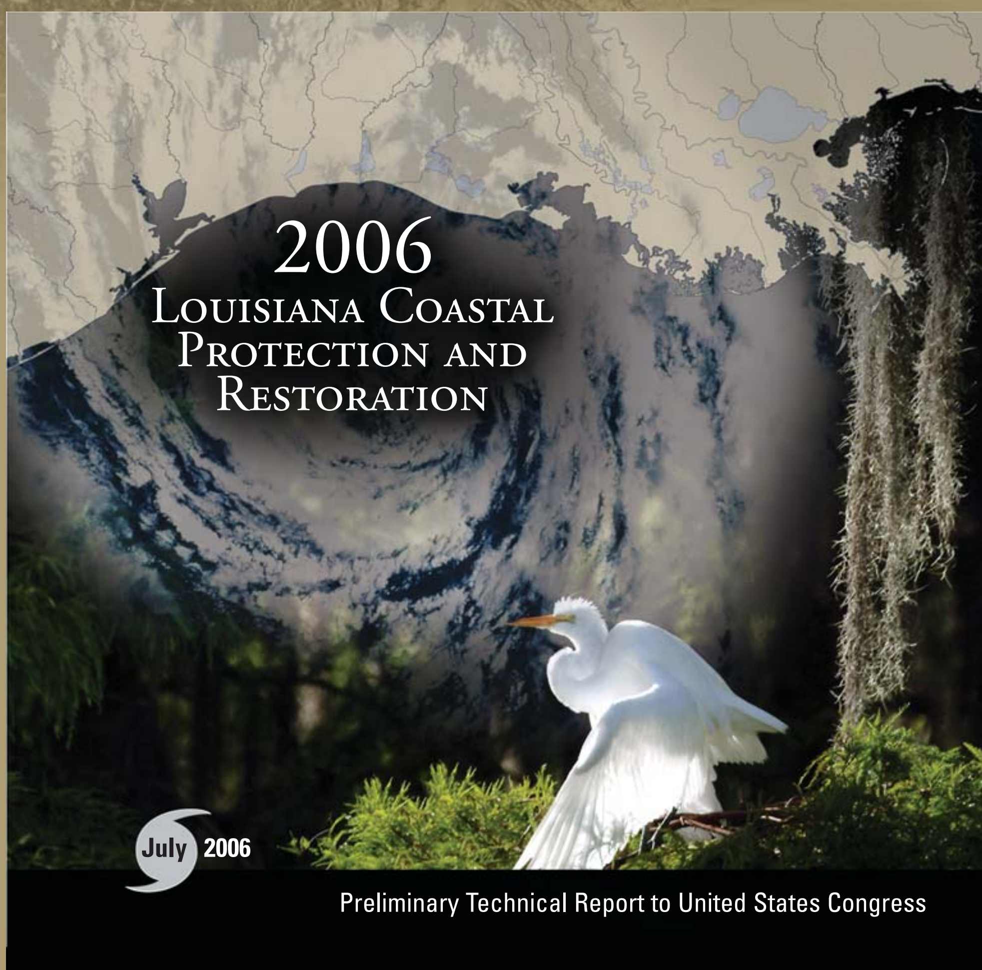
A Synthetic Storm Method is a technique used in the development of an artificial storm(s) utilizing artificial storm parameters or storm parameters for various storms to make a storm or storms. This approach generates a data base that is statistically similar to an actual storm data base and may be used to expand or create a data set where a data set is either non-existent or under populated with actual storm data.

Scenic Sunset Along a Louisiana Bayou

Fishing Camps Along Bayou Lafourche

Shrimp Boat in Louisiana Coastal Waters

- United States Army Corps of Engineers
  - Headquarters
  - Mississippi Valley Division
  - New Orleans District
  - Vicksburg District
  - South Atlantic Division
  - Mobile District
  - Baltimore District
  - Philadelphia District
  - New York District
  - Huntington District
  - Engineering Research and Development Center
  - Institute for Water Resources
- State of Louisiana
- State of Louisiana Governor's Office
- Louisiana Recovery Authority
- Louisiana Coastal Protection and Restoration Authority
- Louisiana Department of Natural Resources – Coastal Engineering Division
- Louisiana Department of Transportation and Development
- Louisiana Department of Wildlife and Fisheries
- Louisiana Department of Environmental Quality
- Louisiana State University
- University of New Orleans
- Tulane University
- University of Louisiana at Lafayette
- University of Notre Dame
- University of North Carolina – Chapel Hill
- University of Maryland
- University of Delaware – Center for Applied Coastal Research
- University of Florida
- Massachusetts Institute of Technology
- Virginia Tech
- Department of Homeland Security – Office of the Federal Coordinator for Gulf Coast Rebuilding
- Minerals Management Service
- Department of Homeland Security – FEMA
- National Oceanic and Atmospheric Administration Hurricane Center
- National Oceanic and Atmospheric Administration - National Ocean Service
- United States Environmental Protection Agency
- National Marine Fisheries Service
- United States Fish and Wildlife Service
- Untied States Geological Survey
- United States Natural Resources Conservation Service
- Delft University
- Dutch Rijkswaterstaat
- Lake Pontchartrain Basin Foundation
- Barataria-Terrebonne National Estuary Program
- Mississippi River Basin Alliance
- Ducks Unlimited
- Bring New Orleans Back Commission
- Restore or Retreat
- Parishes Against Coastal Erosion
- Louisiana Landowners Association
- City of New Orleans
- St. Tammany Parish
- Calcasieu Parish
- St. Bernard Parish
- Jefferson Parish
- Lafourche Parish
- Terrebonne Parish
- St. Mary Parish
- St. Charles Parish
- Town of Berwick
- Pontchartrain Levee District
- R.R.A.B.B. Levee District
- Port of Lake Charles
- Applied Research Associates
- HDR Inc.
- UNESCO-IHE – Institute of Water Education
- IIHR Hydroscience and Engineering
- Rensselaer Polytechnic Institute
- URS Corporation
- ARCADIS
- Coastal Environments Inc.
- Schnabel Foundation Company
- Nicholson Construction
- SolidGeo AB
- Brown, Cunningham, and Gannuch, Inc.
- Gore Engineering, Inc.
- Eustis Engineering Company, Inc.
- Lourie Consultants
- CDM
- TNO
- Raito, Inc.
- Hawyard Baker, Inc.
- Shaw Coastal
- Waldemar S. Nelson & Co., Inc.
- Exponent-Failure Analysis Associates, Inc.
- Strategic Planning Associates
- Gahagn & Bryant Associates
- Miller Engineers and Associates
- Cheniere Energy, Inc.
- Hartman Engineering
- ePrime Communications
- Washington Group International


2006
Louisiana Coastal
Protection and
Restoration
July 2006
Preliminary Technical Report to United States Congress

Breach in the 17th Street Canal New Orleans, Louisiana

By many measures the 2005 hurricane season was the worst in the Nation's history. Storms striking the Louisiana coast took over 1,800 lives, destroyed billions of dollars of residential, commercial, and public property, and changed the landscape of the Louisiana coast. Across America and around the world people were shocked by the images of destruction along the Gulf Coast in the most active Atlantic hurricane season in recorded history, witnessing the unprecedented formation of three powerful "Category 5" storms in the Gulf of Mexico. In response, the U.S. Congress has directed the Secretary of the Army, through the Chief of the U.S. Army Corps of Engineers to *"conduct a comprehensive hurricane protection analysis and design…to develop and present a full range of flood control, coastal restoration, and hurricane protection measures...[and] the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane...[and] the analysis shall be conducted in close coordination with the State of Louisiana."* This Preliminary Technical Report presents the planning, design, and analysis efforts that are part of the Louisiana Coastal Protection and Restoration effort. A vision for success has emerged from the LACPR preliminary efforts. A "Category 5" storm striking Louisiana presents extreme weather conditions requiring planners and designers to develop multiple lines of defense using an integrated system of restored coastal features, strong structural barriers and levees, and non-structural features to protect lives and property.

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